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CONTENTS:

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ON THE PART PLAYED BY ACCIDENT IN INVENTION AND DISCOVERY.[1]

IT is characteristic of the naïve and sanguine beginnings of thought in youthful men and nations, that all problems are held to be soluble and fundamentally intelligible on the first appearance of success. The sage of Miletus, on seeing the plant take its rise from moisture, believed he had comprehended the whole of nature, and he of Samos, on discovering that definite numbers corresponded to the lengths of harmonical strings, imagined he could exhaust the nature of the world by means of numbers. Philosophy and science in such periods are blended. Wider experience, however, speedily discloses the error of this course, gives rise to criticism, and leads to the division and ramification of the sciences.

At the same time, the necessity of a broad and general view of the world remains; and to meet this need philosophy parts company with special inquiry. It is true, the two are often found united in gigantic personalities. But as a rule their ways diverge more and more widely from each other. And if the estrangement of philosophy from science can reach a point where data unworthy of the nursery are deemed none too scanty as foundations of the world, on the other hand the thorough-paced specialist may go to the extreme

[1] Inaugural lecture delivered on assuming the Professorship of the History and Theory of Inductive Science in the University of Vienna, October 20, 1895. (Unpublished.) Translated by Thomas J. McCormack.

of rejecting point-blank the possibility of a broader view, or at least of deeming it superfluous, forgetful of Voltaire's apophthegm, nowhere more applicable than here, *Le superflu—chose très nécessaire.*

It is true, the history of philosophy, owing to the insufficiency of its constructive data, is and must be largely a history of error. But it would be the height of ingratitude on our part to forget that the seeds of thoughts which still fructify the soil of special research, such as the theory of irrationals, the conceptions of conservation, the doctrine of evolution, the idea of the specific energies, and so forth, may be traced back in distant ages to philosophical sources. Furthermore, to have deferred or abandoned the attempt at a broad philosophical view of the world from a full knowledge of the insufficiency of our materials, is quite a different thing from never having undertaken it at all. The revenge of its neglect, moreover, is constantly visited upon the specialist by his committal of the very errors which philosophy long ago disclosed. As a fact, in physics and physiology, particularly during the first half of this century, are to be met intellectual productions which for naïve simplicity yield not an iota to those of the Ionian school, or to the Platonic ideas, or to that much reviled ontological proof.

Latterly, there has been evidence of a gradual change in this state of affairs. Recent philosophy has set itself more modest and more attainable ends; she is no longer inimical to special inquiry; in fact, she is zealously taking a part in that inquiry. On the other hand, the special sciences, mathematics and physics, no less than philology, have become eminently philosophical. The material presented is no longer accepted uncritically. The glance of the inquirer is bent to the neighboring fields, whence that material has been derived. The different special departments are striving for closer union, and gradually the conviction is gaining ground that philosophy can consist only of mutual, complemental criticism, interpenetration, and union of the special sciences into a consolidated whole. As the blood in nourishing the body separates into countless capillaries, only to be collected again and to meet in the heart, so in the science of the future all the rills of knowledge will be gathered more and more into a common and undivided stream.

It is this view—not an unfamiliar one to the present generation—that I purpose to advocate. Cherish no hope, or rather have no fear, that I shall erect systems for you. I shall remain a natural inquirer. Nor expect that it is my intention to skirt all the fields of natural inquiry. I can attempt to be your guide only in that branch which is familiar to me, and even there I can assist in the furtherment of only a small portion of the allotted task. If I shall succeed in rendering plain to you the relations of physics, psychology, and the theory of knowledge, so that you may draw from each of them profit and light, redounding to each, I shall regard my work as not having been in vain. Therefore, to illustrate by an example how, consonantly with my powers and views, I conceive such inquiries should be conducted, I shall treat to-day, in the form of a brief sketch, of the following special and limited subject—of *the part which accidental circumstances play in the development of inventions and discoveries.*

* * *

When we Germans say of a man that he was not the inventor of gunpowder,[1] we impliedly cast a grave suspicion on his abilities. But the expression is not a felicitous one, as there is probably no invention in which deliberate thought had a smaller, and pure luck a larger, share than in this. It is well to ask, Are we justified in placing a low estimate on the achievement of an inventor because accident has assisted him in his work? Huygens, whose discoveries and inventions are justly sufficient to entitle him to an opinion in such matters, lays great emphasis on this factor. He asserts that a man capable of inventing the telescope without the concurrence of accident must have been gifted with superhuman genius.[2]

A man living in the midst of civilisation finds himself surrounded by a host of marvellous inventions, considering none other than the means of satisfying the needs of every-day life. Picture such

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[1] The phrase is, *Er hat das Pulver nicht erfunden.*

[2] "Quod si quis tanta industria exstitisset, ut ex naturae principiis et geometria hanc rem eruere potuisset, eum ego supra mortalium sortem ingenio valuisse dicendum crederem. Sed hoc tantum abest, ut fortuito reperti artificii rationem non adhuc satis explicari potuerint viri doctissimi."—Hugenii Dioptrica (de telescopiis).

a man transported to the epoch preceding the invention of these ingenious appliances, and imagine him undertaking in a serious manner to comprehend their origin. At first the intellectual power of the men capable of producing such marvels will strike him as incredible, or, if we adopt the ancient view, as divine. But his astonishment is considerably allayed by the disenchanting yet elucidative revelations of the history of primitive culture, which to a large extent prove that these inventions took their rise very slowly and by imperceptible degrees.

A small hole in the ground with fire kindled in it constituted the primitive stove. The flesh of the quarry, wrapped with water in its skin, was boiled by contact with heated stones. Cooking by stones was also performed in wooden vessels. Hollow gourds were protected from the fire by coats of clay. Thus, from the burned clay accidentally originated the enveloping pot, which rendered the gourd superfluous, although for a long time thereafter the clay was still spread over the gourd, or pressed into woven wicker-work, before the potter's art assumed its final independence. Even then the wicker-work ornament was retained, as a sort of attest of its origin.

We see, thus, it is by accidental circumstances, that is, by such as lie without his purpose, foresight, and power, that man is gradually led to the acquaintance of improved means of satisfying his wants. Let the reader picture to himself the genius of a man who could have foreseen without the help of accident that clay handled in the ordinary manner would produce a useful cooking utensil! The majority of the inventions made in the early stages of civilisation, including language, writing, money, and the rest, could not have been the product of deliberate methodical reflexion for the simple reason that no idea of their value and significance could have been had except from their practical use. The invention of the bridge may have been suggested by the trunk of a tree which had fallen athwart a mountain-torrent; that of the tool by the use of a stone accidentally taken into the hand to crack nuts. The use of fire probably started in and was disseminated from regions where volcanic eruptions, hot springs, and burning jets of natural gas

afforded opportunity for quietly observing and turning to practical account the properties of fire. Only after that had been done could the significance of the fire-drill be appreciated, an instrument which was probably discovered by boring a hole through a piece of wood. The suggestion of a distinguished inquirer that the invention of the fire-drill originated on the occasion of a religious ceremony is both fantastic and incredible. And as to the use of fire, we should no more attempt to derive that from the invention of the fire-drill than we should from the invention of sulphur matches. Unquestionably the opposite course was the real one.[1]

Similar phenomena, though still largely veiled in obscurity, mark the initial transition of nations from a hunting to a nomadic life and to agriculture.[2] We shall not multiply examples, but content ourselves with the remark that the same phenomena recur in historical times, in the ages of great technical inventions, and, further, that regarding them the most whimsical notions have been circulated—notions which ascribe to accident an unduly exaggerated part, and one which in a psychological respect is absolutely impossible. The observation of steam escaping from a tea-kettle and of the clattering of the lid is supposed to have led to the invention of the steam-engine. Just think of the gap between this spectacle and the conception of the performance of a large amount of work by steam, for a man totally ignorant of the steam-engine! Let us suppose, however, that an engineer, versed in the practical construction of pumps, should accidentally dip into water an inverted bottle that had been filled with steam for drying and still retained its steam. He would see the water rush violently into the bottle, and the idea would very naturally suggest itself of founding on this experience a convenient and useful atmospheric steam-pump, which by imperceptible degrees, both psychologically possible and immediate, would then undergo a natural and gradual transformation into Watt's steam-engine.

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[1] I must not be understood as saying that the fire-drill has played no part in the worship of fire or of the sun.

[2] Compare on this point the extremely interesting remarks of Dr. Paul Carus in his *Philosophy of the Tool*, Chicago, 1893.

But granting that the most important inventions are brought to man's notice accidentally and in ways that are beyond his foresight, yet it does not follow that accident alone is sufficient to produce an invention. The part which man plays is by no means a passive one. Even the first potter in the primeval forest must have felt some stirrings of a genius within him. In all such cases, the inventor is obliged *to take note* of the new fact, he must discover and grasp its advantageous feature, and must have the power to turn that feature to account in the realisation of his purpose. He must *distinguish* the new feature, impress it upon his memory, unite and interweave it with the rest of his thought; in short, he must possess the capacity *to profit by experience.*

The capacity to profit by experience might well be set up as a test of intelligence. That power varies considerably in men of the same race, and increases enormously as we advance from the lower animals to man. The former are limited almost entirely to the reflex actions which they have inherited with their organism, they are almost totally incapable of individual experience, and considering their simple wants are scarcely in need of it. The ivory-snail (*Eburna spirata*) never learns to avoid the carnivorous Actinia, no matter how often it may wince under the latter's shower of needles, having apparently no memory whatever for pain.[1] A spider can be lured forth repeatedly from its hole by touching its web with a tuning-fork. The moth plunges again and again into the flame which has burnt it. The humming-bird hawk-moth[2] dashes repeatedly against the painted roses of the wall-paper, like the unhappy and desperate thinker who never wearies of attacking in the same way the same insoluble chimerical problem. As aimlessly almost as Maxwell's gaseous molecules and in the same unreasoning manner common flies in their search for light and air stream against the glass pane of a half-opened window and remain there from sheer inability to find their way around the narrow frame. But

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[1] Möbius, *Naturwissenschaftlicher Verein für Schleswig-Holstein*, Kiel, 1893, p. 113 et seq.

[2] I am indebted for this observation to Professor Hatscheck.

a pike separated from the minnows of his aquarium by a glass partition, learns after the lapse of a few months, though only after having butted himself half to death, that he cannot attack these fishes with impunity. What is more, he leaves them in peace even after the removal of the partition, though he will bolt at once a strange fish. Considerable memory must be attributed to birds of passage, a memory which, probably owing to the absence of disturbing thoughts, acts with the precision of that of some idiots. Finally, the susceptibility to training evinced by the higher vertebrates is indisputable proof of the ability of these animals to profit by experience.

A powerfully developed *mechanical* memory, which recalls vividly and faithfully old situations, is sufficient for avoiding definite particular dangers, or for taking advantage of definite particular opportunities. But more is required for the development of *inventions*. More extensive chains of images are necessary here, the excitation by mutual contact of widely different trains of ideas, a more powerful, more manifold, and richer connexion of the contents of memory, a more powerful and impressionable psychical life, heightened by use. A man stands on the bank of a mountain-torrent, which is a serious obstacle to him. He remembers that he has crossed just such a torrent before on the trunk of a fallen tree. Hard by trees are growing. He has often moved the trunks of fallen trees. He has also felled trees before, and then moved them. To fell trees he has used sharp stones. He goes in search of such a stone, and as the old situations that crowd into his memory and are held there in living reality by the definite powerful interest which he has in crossing just this torrent,—as these impressions are made to pass before his mind in the *inverse order* in which they were here evoked, he invents the bridge.

There can be no doubt but the higher vertebrates adapt their actions in some moderate degree to circumstances. The fact that they give no appreciable evidence of advance by the accumulation of inventions, is satisfactorily explained by a difference of degree or intensity of intelligence as compared with man; the assumption of a difference of kind is not necessary. A person who saves a little

every day, be it ever so little, has an incalculable advantage over him who daily loses that amount, or is unable to keep what he has accumulated. A slight quantitative difference in such things explains enormous differences of advancement.

The rules which hold good in prehistoric times also hold good in historical times, and the remarks made on invention may be applied almost without modification to discovery; for the two are distinguished solely by the use to which the new knowledge is put. In both cases the investigator is concerned with some *newly observed* relation of new or old properties, abstract or concrete. It is observed, for example, that a substance which gives a chemical reaction *A* is also the cause of a chemical reaction *B*. If this observation fulfils no purpose but that of furthering the scientist's insight, or of removing a source of intellectual discomfort, we have a discovery; but an invention, if in using the substance giving the reaction *A* to produce the desired reaction *B*, we have a practical end in view, and seek to remove a cause of material discomfort. The phrase, *disclosure of the connexion of reactions*, is broad enough to cover discoveries and inventions in all departments. It embraces the Pythagorean proposition, which is a combination of a geometrical and an arithmetical reaction, Newton's discovery of the connexion of Kepler's motions with the law of the inverse squares, as perfectly as it does the detection of a small appropriate alteration in the construction of a tool, or of an appropriate change in the methods of work of a dyeing establishment.

The disclosure of new provinces of facts before unknown can only be brought about by accidental circumstances, under which are *remarked* facts that commonly go unnoticed. The achievement of the discoverer here consists in his *sharpened attention*, which detects the uncommon features of an occurrence and their determining conditions from their most evanescent marks,[1] and discovers means of submitting them to exact and full observation. Under this head belong the first disclosures of electrical and magnetic phenomena, Grimaldi's observation of interference, Arago's discovery of the in-

[1] Cf. Hoppe, *Entdecken und Finden*. 1870.

creased check suffered by a magnetic needle vibrating in a copper envelope as compared with that observed in a bandbox, Foucault's observation of the stability of the plane of vibration of a rod accidentally struck while rotating in a turning-lathe, Mayer's observation of the increased redness of venous blood in the tropics, Kirchhoff's observation of the augmentation of the *D*-line in the solar spectrum by the interposition of a sodium lamp, Schönbein's discovery of ozone from the phosphoric smell emitted on the disruption of air by electric sparks, and a host of others. All these facts, of which unquestionably many were *seen* numbers of times before they were *noticed*, are examples of the inauguration of momentous discoveries by accidental circumstances, and place the importance of strained attention in a brilliant light.

But not only is a significant part played in the beginning of an inquiry by co-operative circumstances beyond the foresight of the investigator; their influence is also active in its prosecution. Dufay, thus, whilst following up the behavior of *one* electrical state which he had assumed, discovers the existence of *two*. Fresnel learns by accident that the interference-bands received on ground glass are seen to better advantage in the open air. The diffraction-phenomenon of two slits proved to be considerably different from what Fraunhofer had anticipated, and in following up this circumstance he was led to the important discovery of grating-spectra. Faraday's induction-phenomenon departed widely from the initial conception which occasioned his experiments, and it is precisely this deviation that constitutes his real discovery.

Every man has pondered on some subject. Every one of us can multiply the examples cited, by less illustrious ones from his own experience. I shall cite but one. On rounding a railway curve once, I accidentally remarked a striking apparent inclination of the houses and trees. I discovered from this that the direction of the total physical acceleration of a mass carries with it as its physiological reaction the perception of the vertical. Afterwards, in attempting to inquire more carefully into this phenomenon, and this only, in a large whirling machine, the collateral phenomena conducted me to the sensation of the angular acceleration, vertigo,

Flouren's experiments on the section of the circular canals, and so on, from which gradually resulted views relating to the sensations of direction which are also held by Breuer and Brown, which were at first contested on all hands, but are now regarded on many sides as correct, and which have been recently enriched by the interesting inquiries of Breuer concerning the *macula acustica*, and Kreidel's experiments with magnetically orientable crustacea. Not disregard of accident but a direct and purposeful employment of it advances research.

The more powerful the psychical connexion of the memory pictures is,—and it varies according to the individual and the mood,—the more apt is the same accidental observation to be productive of results. Galileo knows that the air has weight; he also knows of the "resistance to a vacuum," expressed both in weight and in the height of a column of water. But the two ideas dwelt asunder in his mind. It remained for Torricelli to vary the specific gravity of the liquid measuring the pressure, and not till then was the air included in the list of pressure-exerting fluids. The reversal of the lines of the spectrum was seen repeatedly before Kirchhoff, and had been mechanically explained. But it was left for his penetrating vision to discern the evidence of the connexion of this phenomenon with questions of heat, and to him alone through persistent labor was revealed the sweeping significance of the fact for the mobile equilibrium of heat. Supposing, then, that such a rich organic connexion of the elements of memory exists, and is the prime distinguishing mark of the inquirer, next in importance certainly is that *intense interest* in a definite object, in a definite idea, which fashions advantageous combinations of thought from elements before disconnected, and obtrudes that idea into every observation made, and into every thought formed, making it enter into relationship with all things. Thus Bradley, deeply engrossed with the subject of aberration, is led to its solution by an exceedingly unobtrusive experience in crossing the Thames. It is permissible, therefore, to ask whether accident leads the discoverer, or the discoverer accident, to a successful outcome in scientific quests.

No man should dream of solving a great problem unless he is

so thoroughly saturated with his subject that everything else sinks into comparative insignificance. During a hurried meeting with Mayer in Heidelberg once, Jolly remarked, with a rather dubious implication, that if Mayer's theory were correct water could be warmed by shaking. Mayer went away without a word of reply. Several weeks later, and now unrecognised by Jolly, he rushed into the latter's presence exclaiming: "Es ischt aso!" (It is so, it is so!). It was only after considerable explanation that Jolly found out what Mayer wanted to say. The incident needs no comment.[1]

A person deadened to sensory impressions and given up solely to the pursuit of his thoughts, also can light on an idea that will divert his mental activity into totally new channels. In such cases it is a psychical accident, an intellectual experience, as distinguished from a physical accident, to which the person owes his discovery—a discovery which is here made "deductively" by means of mental copies of the world, instead of experimentally. *Purely* experimental inquiry, moreover, does not exist, for, as Gauss says, virtually we always experiment with our thoughts. And it is precisely that constant, corrective interchange or intimate union of experiment and deduction, as it was cultivated by Galileo in his *Dialogues* and by Newton in his *Optics*, that is the foundation of the benign fruitfulness of modern scientific inquiry as contrasted with that of antiquity, where observation and reflexion ofttimes pursued their several courses like two strangers.

We have to wait for the appearance of a favorable physical accident. The movement of our thoughts obeys the law of association. In the case of meagre experience the result of this law is simply the mechanical reproduction of definite sensory experiences. On the other hand, if the psychical life is subjected to the incessant influences of a powerful and rich experience, then every representative element in the mind is connected with so many others that the actual and natural course of the thoughts is easily influenced and determined by insignificant circumstances, which accidentally are decisive. Hereupon, the process termed imagination produces

[1] This story was related to me by Jolly, and subsequently repeated in a letter from him.

its protean and infinitely diversified forms. Now what can we do to guide this process, seeing that the combinatory law of the images is without our reach? Rather let us ask, what influence can a powerful and constantly recurring idea exert on the movement of our thoughts? According to what has preceded, the answer is involved in the question itself. The *idea* dominates the thought of the inquirer, not the latter the former.

Let us see, now, if we can acquire a profounder insight into the process of discovery. The condition of the discoverer is, as James has aptly remarked, not unlike the situation of a person who is trying to remember something that he has forgotten. Both are sensible of a gap, and have only a remote presentiment of what is missing. Suppose I meet in company a well-known and affable gentleman whose name I have forgotten, and who to my horror asks to be introduced to someone. I set to work according to Lichtenberg's rule, and run down the alphabet in search of the initial letter of his name. A vague sympathy holds me at the letter *G*. Tentatively I add the second letter and am arrested at *e*, and long before I have tried the third letter *r*, the name "Gerson" breaks sonorously upon my ear, and my anguish is gone. While taking a walk I meet a gentleman from whom I receive a communication. On returning home, and in attending to weightier affairs, the matter slips my mind. Moodily, but in vain, I ransack my memory. Finally I observe that I am going over my walk in thought. On the street corner in question the gentleman again stands before me and repeats his communication. In this process are recalled successively to consciousness all the percepts which were connected with the percept that was lost, and with them, finally, that, too, is brought to light. In the first case—where the experience had already been made and is permanently impressed on our thought—a *systematic* procedure is both possible and easy, for we know that a name must be composed of a limited number of sounds. But at the same time it should be observed that the labor involved in such a combinatorial task would be enormous if the name were long and the responsiveness of the mind weaker.

It is often said, and not wholly without justification, that the

scientist has solved a *riddle*. Every problem in geometry may be clothed in the garb of a riddle. Thus: "What thing is that *M* which has the properties *A*, *B*, *C*?" "What circle is that which touches the straight lines *A*, *B*, touching *B* in the point *C*?" The first two conditions marshal before the imagination the group of circles whose centres lie in the line of symmetry of *A*, *B*. The third condition reminds us of all the circles having centres in the straight line which stands at right angles to *B* in *C*. The *common* term, or common terms, of these groups of images solve the riddle—satisfy the problem. Puzzles dealing with things or words induce similar processes, but the memory in such cases is exerted in many directions and more varied and less clearly ordered provinces of ideas have to be surveyed. The difference between the situation of a geometer who has a construction to make, and that of an engineer, or a scientist, confronted with a problem, is simply this, that the first moves in a field with which he is thoroughly acquainted, whereas the two latter are obliged to familiarise themselves with this field subsequently, and in a measure far transcending what is commonly required. In this process the mechanical engineer has at least always a definite goal before him and definite means to accomplish his aim, whilst in the case of the scientist that aim is in many instances presented only in vague and general outlines. Often the very formulation of the riddle devolves on him. Frequently it is not until the aim has been reached that the broader outlook requisite for systematic procedure is obtained. By far the larger portion of his success, therefore, is contingent on luck and instinct. It is immaterial, so far as its character is concerned, whether the process in question is brought rapidly to a conclusion in the brain of one man, or whether it is spun out for centuries in the minds of a long succession of thinkers. The same relation that a word solving a riddle bears to that riddle is borne by the modern conception of light to the facts discovered by Grimaldi, Römer, Huygens, Newton, Young, Malus, and Fresnel, and only by the help of this slowly developed conception is our mental vision enabled to embrace the broad domain of facts in question.

A welcome complement to the discoveries which the history of

civilisation and comparative psychology have furnished, is to be found in the confessions of great scientists and artists. Scientists *and* artists, we might say, for Liebig courageously declared there was no essential difference between the labors of the two. Are we to regard Leonardo da Vinci as a scientist or as an artist? If it is the business of the artist to build up his work from a few motives, it is the task of the scientist to discover the motives which permeate reality. If scientists like Lagrange or Fourier are in a certain measure artists in the presentation of their results, on the other hand, artists like Shakespeare or Ruysdael are scientists in the insight which must have preceded their creations.

Newton, when questioned about his methods of work, could give no other answer but that he was wont to ponder again and again on a subject; and similar utterances are accredited to D'Alembert and Helmholtz. Scientists and artists both recommend persistent labor. After the repeated survey of a field has afforded opportunity for the interposition of advantageous accidents, has rendered all the traits that suit with the mood or the dominant thought more vivid, and has gradually relegated to the background all things that are inappropriate, making their future appearance impossible; then from the teeming, swelling host of fancies which a free and high-flown imagination calls forth, suddenly that particular form arises to the light which harmonises perfectly with the ruling idea, mood, or design. Then it is that that which has resulted slowly as the result of a gradual selection, appears as if it were the outcome of a deliberate act of creation. Thus are to be explained the statements of Newton, Mozart, Richard Wagner, and others, when they say that thoughts, melodies, and harmonies had poured in upon them, and that they had simply retained the right ones. Undoubtedly, the man of genius, too, consciously or instinctively, pursues systematic methods, wherever it is possible; but in his delicate presentiment he will omit many a task or abandon it after a hasty trial on which a less endowed man would squander in vain his energies. Thus, the genius accomplishes[1] in a brief space of

[1] I do not know whether Swift's academy of schemers in Lagado, in which great discoveries and inventions were made by a sort of verbal game of dice, was in-

time undertakings for which the life of an ordinary man would far from suffice. We shall hardly go astray if we regard genius as only a slight deviation from the average mental endowment—as possessing simply a greater sensitiveness of cerebral reaction and a greater swiftness of reaction. The men who, obeying their inner impulses, make sacrifices for an idea instead of advancing their material welfare, may appear to the full-blooded Philistine as fools; yet we shall scarcely adopt Lombroso's view, that genius is to be regarded as a disease, although it is unfortunately true that a more sensitive brain, a more fragile constitution, succumbs far more readily to sickness.

The remark of C. G. J. Jacobi that mathematics is slow of growth and only reaches the truth by long and devious paths, that the way to its discovery must be prepared for long beforehand, and that then the truth will make its long-deferred appearance as if impelled by some divine necessity[1]—all this holds true of every science. We are astounded often to note that it required the combined labors of many eminent thinkers for a full century to reach a truth which it takes us only a few hours to master and which once acquired seems extremely easy to reach under the right sort of circumstances. To our humiliation we learn that even the greatest men are born more for life than for science. The extent to which even they are indebted to accident—to that singular conflux of the physical and the psychical life in which the continuous but yet imperfect and never-ending adaptation of the latter to the former finds its distinct expression—that has been the subject of our remarks to-day. Jacobi's poetical thought of a divine necessity acting in science will lose none of its loftiness for us if we discover in this necessity the same power that destroys the unfit and fosters the fit. For loftier, nobler, and more romantic than poetry is the truth and the reality.

VIENNA. E. MACH.

tended as a satire on Francis Bacon's method of making discoveries by means of huge synoptic tables constructed by scribes. It certainly would not have been ill-placed.

[1] The original passage in Latin is quoted by Simony, *In ein ringförmiges Band einen Knoten zu machen*, Vienna, 1881, p. 41.

PATHOLOGICAL PLEASURES AND PAINS.[1]

THE title of this article may appear paradoxical, pleasure being ordinarily the expression of a state of health or even of exuberance of life, whilst pain is by definition a diseased state. It must be acknowledged that the expression "abnormal" would be preferable. Nevertheless, the facts which form the subject of our study are not uncommon and deserve separate consideration, for the anomalies and deviations of pleasure and pain serve to give us a better insight into their nature.

The application of the pathological method to psychology is in need of no justification; its title is already established. The results obtained are too numerous and too well known to require enumeration. The principal advantages of the method are two: (1) It is an instrument of amplification, and magnifies the normal phenomenon. (Hallucination enables us to understand better the rôle of the image, and hypnotic suggestion throws a flood of light on the suggestion of common life.) (2) It is an invaluable instrument of analysis. Pathology, it has been justly said, is simply physiology deranged; for nothing enables us to understand a mechanism better than the suppression or the displacement of one of its wheels. Aphasia produces a decomposition of memory, and discloses properties, which the subtlest psychological analysis could never have compassed, nor even have foreshadowed.

The principal difficulty in this method consists in determining the precise moment at which it can be applied. The distinction of health and disease is at times extremely troublesome. Undoubtedly

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[1] Translated from Professor Ribot's manuscript by Thomas J. McCormack.

there are cases where hesitation is impossible; but there are border zones which fluctuate widely between disease and health. Claude Bernard has ventured to write: "The normal state so called is a pure fiction of the mind, an ideal typical form entirely denuded of the thousand and one divergences between which the organism incessantly oscillates amid its alternating and intermittent functions." If this is true of health of body, how much more is it so of health of mind. The dilemma, That man is insane or not insane, says Griesinger, is absolutely devoid of meaning in many cases. The psychical organism, being more complex and more unstable than the physical organism, admits far less easily of the establishment of a norm. Finally that difficulty attains its maximum in our subject, because the emotional life which is the most mobile of all the forms of the psychical life oscillates incessantly about a point of equilibrium and is constantly apt to fall too low or to rise too high.

But as it is imperative to decide upon the adoption of some characters as pathological marks, or criteria, in distinguishing the healthy from the unhealthy in the affective sphere, we shall adopt those enunciated by Féré. According to him an emotion may be considered morbid:

(1) When its physiological concomitants appear with extraordinary intensity. [It would seem proper to add "or with extraordinary depression."]

(2) When it is produced without a sufficient determining cause.

(3) When its effects are unduly prolonged.[1]

These three criteria, which I shall call, abnormal reaction by excess or deficit, (apparent) disproportion between cause and effect, chronicity, may often be used to advantage in the study of the morbid emotions. For the present we are concerned only with pleasure and pain.

I.

Let us begin with pleasure. I shall examine first a typical case studied by many psychologists, but of which none in my opinion

[1] Féré, *Pathologie des émotions*, p. 223.

has given a satisfactory explanation. I refer to the particular state that has been called *the luxury of grief* (Spencer), *pleasure in pain* (Bouillier), but which might more precisely be called *the pleasure of pain.* It consists in the willing embrace of suffering and in the enjoyment of it as genuine pleasure.

This disposition of the soul is not, as might be supposed, exclusively characteristic of *blasé* people and of artificial civilisations; it seems to be inherent in humanity on its first emergence from barbarism. Bouillier[1] has pointed out among the authors of antiquity passages which mention it, not only in Lucretius, Seneca, and other moralists, but in the poems of Homer, themselves a reflex of an extremely primitive civilisation and of one furthermore in which "people rejoiced in their tears." They are to be found, I suppose, in the Bible and in the epics of ancient India. We are dealing, therefore, with no unusual phenomenon; although the further we advance in civilisation the more frequent is its appearance.

But facts will avail more than quotations. They are various in kind: pleasure of physical pain, pleasure of moral pain. Some patients experience an intense voluptuousness in irritating their wounds. "I have known," says Mantegazza, "an old man who confided to me that he found extraordinary pleasure, inferior to no other he had ever experienced, in scratching the inflamed edges of an old sore on his leg, from which he had suffered for several years."[2] A celebrated scholar of the Renaissance, Jerome Cardan, tells us in his autobiography, "that he could never go without suffering, and that when such befel him, he was conscious of a gathering impetuosity which welcomed additional pain, of any sort and however great, as a positive relief." Thus, he was wont in this condition to torture his body till the tears came.[3] We might continue with a long enumeration of the pleasures of physical pain. Of the pleasure of mental pain I shall give but one instance: melan-

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[1] Bouillier, *Du plaisir et de la douleur*, Chap. VII.

[2] Mantegazza, *Fisiologia del piacere*, p. 26.

[3] A curious study in pathological psychology awaits the psychologist in the *De Vita Propria* of Cardan, who was manifestly what in our days is called a neuropath, a non-equilibrate.

choly in the ordinary, not in the medical, signification of the word, viz., that of lovers, of poets, of artists, etc.,—a state which may be regarded as the type of the complaisant degustation of sadness. There is none of us but can be sad, if we wish, but not melancholical. I shall further mention in passing the pleasures of the ugly in æsthetics, and the taste for bloody spectacles and tortures.

Let us leave the facts, now, for the attempts at explanation which have been proposed. They are not numerous. Bouillier (*loc. cit.*) appears to adopt the opinion of a Cartesian, who says: "If the soul in all its movements of passion, even in its most painful, is in some sort gratified by the secret pain it suffers; if it willingly embraces this pain; if it repulses all proffers of consolation; it is because it is conscious that the state in which it exists is the state of heart and mind which best accords with the situation." I do not understand this pretended explanation. I prefer that of Hamilton, who finds the principal cause "in the superaddition of activity which the feeling of our sufferings imparts to our whole being." This, at least, is logical, inasmuch as the pleasure is referred to its ordinary correlative—increase of activity. Spencer has treated the problem at some length. He says:[1]

"Here I will draw attention only to one other egoistic sentiment; and I do this chiefly because of its mysterious nature. It is a pleasurably-painful sentiment, of which it is difficult to identify the nature, and still more difficult to trace the genesis. I refer to what is sometimes called "the luxury of grief." . . . It seems possible that this sentiment, which makes a sufferer wish to be alone with his grief, and makes him resist all distraction from it, may arise from dwelling on the contrast between his own worth as he estimates it and the treatment he has received—either from fellow-beings or from a power which he is prone to think of anthropomorphically. If he feels that he has deserved much while he has received little, and still more if instead of good there has come evil, the consciousness of this evil is qualified by the consciousness of worth, made pleasurably dominant by the contrast . . ., there is an idea of much withheld, and a feeling of implied superiority to those who withhold it. . . . That this explanation is the true one, I feel by no means clear. I throw it out simply as a suggestion: confessing that this peculiar emotion is one which neither analysis nor synthesis enables me clearly to understand."

[1] *Principles of Psychology*, Vol. II., § 518.

The foregoing explanation seems to me to be only a partial one and inapplicable to all cases. In my opinion, all attempts of this sort are doomed to failure because their authors proceed on the assumptions of normal psychology. The phenomena in question should be treated by the pathological method. It will be objected, possibly, that this is but substituting one word for another. But that this is not the case, will be seen from the following.

Psychologists have made the mistake of attacking the phenomena from the beginning in too delicate a form, and of considering them separately. They should have proceeded, not by the way of synthesis, nor by that of analysis, but by the method of amplification. What is necessary is to establish a series, in which the last terms, enormously magnified, shed light on the first. Let me indicate the principal stages of the gradation: æsthetic, transitory, and intermittent melancholia; spleen; melancholia in the medical sense of the term. "One abnormal mode of feeling in melancholic patients," remarks Krafft-Ebing, "is the happiness of pain (*Leidseligkeit*). Ideas, which in the healthy state would provoke pain, excite in the afflicted consciousness of these patients a weak sentiment of satisfaction which expresses their corresponding affective tone." Going further, we meet with a tendency to suicide, and finally with suicide itself. The last term furnishes a key to the understanding of all the others. The first are simply *embryonic forms, abortive or mitigated, of the creature's tendency towards its own destruction, or of the desire which regards that end as an agreeable consummation.* Checked in the immense majority of cases, the feeble forms are yet an initial step towards the destruction, and can only be explained by approach from the extreme case.

Evolutionists have advanced the hypothesis of animals so constituted that pleasure in their case was coupled with destructive acts, and pain with beneficial acts; and that as every animal seeks pleasure and avoids pain, such animals are bound to perish from their very nature. The supposition is not chimerical, for we constantly see men delighting in acts which they know perfectly well will speedily lead to their taking-off. A being thus constituted is

abnormal, illogical, and bears within him a self-contradiction which can only result in his annihilation.

But, it may be said, if pain and harmful actions on one side and pleasure and beneficial actions on the other, form indissoluble couples, so that a painful state in consciousness is the equivalent of destructive acts in the organism, and *vice versa*, we should have, in the case supposed, necessarily an inversion—pleasure would express disorganisation, pain reorganisation. The hypothesis in question, which is improbable on its face, does not appear necessary. If we admit that pleasure and pain always exist by virtue of simultaneous and contrary processes, of which the sole difference exists in consciousness, it is sufficient if one of the two processes augments or the other diminishes abnormally, for the difference also to alter in favor of the one or the other. Unquestionably, the ultimate result is a contradiction of the rule, because in the cases considered the surplus which should be negative (pain) is positive (pleasure); and this a fresh proof that we are confronted with a deviation, with an anomaly, with a pathological case, which should be treated accordingly.

We have selected and studied a typical case; it remains for us, not to enumerate, but to classify pathological pleasures, in order to show their frequency.

Taking as our guide the excellent definition of Mantegazza, "morbid pleasure is one which is the cause or the effect of a disease," I distribute them into the following three classes:

1. *Semi-pathological pleasures.* These form a transition from the healthy to the morbid-sound. They are such as require an excessive or prolonged expenditure of vital energy. It is known that pleasures of taste, of smell, of sight, of hearing, of touch, of muscular exercise, of sexual intercourse, produce fatigue and exhaustion, or even suddenly become painful. The pleasures of dotage, of self-love, of possession, when transformed into passions, that is, when increased in intensity and stability, cease to be pure pleasures: a painful element is mingled with them. This phenomenon is natural and logical, since all augmentation of activity carries with it losses and consequently the conditions of pain. The present

class is scarcely morbid, because the pain succeeds the pleasure. This is not the case with the next two, where the pleasure springs directly from the destruction and is alone dominant in consciousness.

(2) *Pleasures destructive of the individual.* I shall not stop at certain anomalies of the taste and smell. But the pleasures due to intoxication and to narcotic stimulants are so widespread as to appear inherent in humanity. At all times and in all places, even among savage races, man has found artificial means of transporting himself, if only for a moment, to spheres of dreams and enchantment. These are pleasures which he has created for his own destruction. But there are cases more striking still, not acquired and invented, cases in which pleasure conceals and dominates the work of disorganisation. Thus, during a certain period of general paralysis the patient believes himself in the possession of unbounded energy, health, riches, and power, and his satisfaction and happiness are expressed in his whole demeanor. Thus, in certain forms of acute mania, the disease is assimilated, on one side, which we shall here neglect, to anger, while on the other side we are confronted with a broad expansive humor, a joy which overflows, a sentiment of energy and vigor. Some of these patients say on their recovery that they have never felt so happy as during their disease (Krafft-Ebing). We might also cite the case of consumptives. Such patients are never so rich in hopes and fertile in projects as when they are on the brink of death. Finally, there is the "euphoria" of the dying. The attempt has been made to explain this by analgesia, as if the suppression of pain were identical with the appearance of joy. Féré, who has examined this question in his *Pathologie des émotions* (p. 170 et seq.), assumes that this exaltation is due to momentary, but positive, conditions of the cerebral circulation.

Must we admit in such cases that, by an almost inconceivable violation of natural determinism, pleasure becomes the expression in consciousness of a profound, implacable disorganisation? Of this there is no need. It is more rational to assume that pleasure is connected here as elsewhere with its natural cause, a superactivity of the vital process. Every pathological pleasure is accompanied

with excitability, but the latter is not a normal activity, lacking which the fever patient or the neuropath would have excess of health. In point of fact, we are confronted by a complex case: on the one side there is a perpetual and enormous waste which proceeds at a tremendous rate without expression in consciousness; on the other side a momentary and conscious superficial excitation. The anomaly lies in this psychical disproportion, or rather, in the myopia of consciousness, which cannot transcend its narrow limits and penetrate to the region of the unconscious.

(3) *Pleasures destructive of the social character.* These are connected not with the sufferings of the individual but with those of others. Such is the pleasure experienced in killing, in seeing persons killed, in bloody spectacles, in bull fights, combats of animals, and, in a far feebler degree, in listening to or in reading accounts of bloody deeds. These pleasures can be explained. They denote the satisfaction of violent and destructive tendencies which, weak or powerful, unconscious or conscious, exist in all men. Their study carries us into the pathology of tendencies which I shall not treat here. I shall simply remark in passing that these tendencies involve a certain expenditure of energy—which is one of the conditions of active pleasure.

A final question. Can pleasure, but particularly joy, be the cause of a grave catastrophe, such as insanity and death?

Some alienists, Bucknill, Tuke, Guislain, and others, have cited cases of insanity which they attribute to sudden joy: an unexpected legacy, a coveted place or honor. Griesinger maintains "that it is extremely rare for immoderate joy alone to produce insanity, if it ever does so." Others deny its possibility absolutely.[1] It is certain that in the enumeration of the causes of insanity joy does not occupy a place.

The same thesis has been upheld with regard to death,[2] which is produced suddenly or as the result of syncope.

But this is entirely too simple a view of the question. In the first place joy, in so far as it is a state of consciousness, could not

[1] Féré, *Pathologie des émotions*, pp. 293, 294.

[2] For the facts, authentic or not, see Féré, *loc. cit.*, p. 233.

have this result. The catastrophe is incapable of being explained except by sudden and violent organic disorders, which could have the indicated effect only on predisposed subjects. It is not joy that kills or drives persons insane, but the shock received by a creature abnormally conditioned. It would be more correct to say that an event which in the common run of men ought to cause joy, produces in the instance in question a particular pathological state which ends in insanity or death.

2.

The reverse side may be treated rapidly. Rare cases are met with of people who are pained at the good fortune falling to their lot: they have the pain of pleasure. I do not know of their having been treated by psychologists, and it does not seem to me worth while to undertake their study. The very opposite in form to the pleasure of pain, it resembles the latter in its foundation. The state of mind met with in certain pessimists is rightly called eccentric or bizarre; the general opinion regards it instinctively as a deviation, as an anomaly. Furthermore, this is but a particular case of a more general condition of existence, namely, of morbid or pathological despondency, which we shall now study. I remarked above that since pain and despondency involve always an element of disease, the expression *abnormal* would be more exact, or less exposed to criticism.

To determine whether a physical or moral pain falls without the rule and should receive the designation abnormal, we have recourse to the three criteria laid down at the beginning of this article, and we may take as a single type *melancholia* in its medical sense. It presents the required characters: long duration, disproportion between the cause and the effect felt, excessive or deficient reaction.

A description of the melancholic state is superfluous, as it may be found in all treatises on mental diseases. The affection has many clinical forms varying from *melancholia attonita* or melancholy with stupor to the cases marked by excitement and incessant groaning, from very light forms to the severe and incurable states. It

will suffice for our present purpose to point out its most general characters. In comparing melancholia with ordinary despondency we are practising the method of amplification or enlargement, the morbid state being simply the normal state in excessive relief.

1. We know that the physiological characters of normal pain are reducible to a single formula: depression of the vital functions. The rule also applies to melancholia; but here the organic depression is much more marked. Constriction of the vaso-motor nerves, whence result a diminution of the size of the arteries, anæmia, coldness of the extremities; decrease of the cardiac pressure, which may drop from a mean of 800 grammes to 650 or even to 500; progressive slackening of the nutrition, with the various symptoms which result therefrom; digestive troubles, stoppage of the secretions; slow and infrequent movements, aversion to all muscular effort, all toil, all exercise of the body; the only exception being in cases of acute melancholia, where there are periods of disordered reflexes and attacks of violent rage. Such is the general picture. We see that it is that of pain pushed to the limits, and that we find here also, as in the normal form, passive and active pains.

2. The psychical characters consist first of an affective state, which varies from stolid resignation to despair; some patients are so completely effaced that they believe they are dead. It has been observed that generally sad characters run to melancholia, and that gay characters tend more to mania: both being exaggerations of the normal state. The intellectual condition consists in a weakening of the association of ideas, in a sluggishness of mind. Ordinarily, a fixed idea predominates, excluding from consciousness everything that is not in accord with it. Thus, the hypochondriac thinks of nothing but his health. A patient suffering from nostalgia thinks only of his country or home, and those afflicted with religious melancholy, only of their salvation. The activity of the will is almost zero; aboulia, "the consciousness of all absence of desire is of the very essence of the malady" (Schüle). At times there are violent and unexpected reflex impulses, constituting a fresh proof of the effacement of the will. In fine, whilst normal despondency has its moments of remittance, melancholia is a prison-house of pain, in

whose impenetrable walls there is no fissure by which a ray of joy can penetrate.

And here arises a question which we cannot neglect, for it is connected with the thesis we have upheld: the fundamental rôle of the affective life. Passive melancholia being taken as the type of the painful state in its permanent and extreme form, what is the origin of that state? Two answers are possible. It may be assumed that a physical pain or a definite image engenders the melancholic disposition and poisons the affective life. It may be assumed that a vague and general state of depression and of disorganisation is constituted and takes fixity in the shape of an idea. On the first hypothesis the intellectual state comes first and the affective state is but its effect. On the second hypothesis, the affective state is first and the intellectual state the result.

This problem, which is less practical than psychological, has engaged the attention of very few alienists. Schüle[1] assumes both origins. At times the patient, suffering with a painful depression which is without cause and which he cannot get rid of, accepts matters as they are; but most frequently he connects his vague feeling of pain with some prior or present event of his life. At times, though still more rarely, the dominant idea appears first, and forms the pivot of the melancholic state and of its sequel. Dr. Dumas, who has devoted a special work to this question,[2] from his own observations comes to the same conclusion as Schüle. One of his patients attributed her incurable despondency, in turns and without sufficient reason, to her husband, to her son, or to the work which she feared she was neglecting. In others, the origin was intellectual: loss of fortune, the idea of irrevocable damnation, etc. Whence the author was led to assume: (1) a melancholia of organic origin, which is most frequent; (2) a melancholia of intellectual origin, which is extremely rare.

Can the two forms in which this malady appears, be referred to

[1] Schüle, *Traité clinique des maladies mentales*. Art. "Melancolie," French translation, pp. 21, 28.

[2] G. Dumas, *Les états intellectuels dans la melancolie*. A number of detailed observations will be found here.

a common and deeper cause? Such is the aim of the following solution of Krafft-Ebing: "It is necessary to consider psychical pain and the inhibition of ideas as co-ordinate phenomena, and then we shall be in a position to discover for these variations a common cause, namely, a nutritive disorder of the brain (anæmia?), leading to a lessened expenditure of nervous activity. Viewed comprehensively, melancholia may be regarded as a morbid state of the psychical organ founded on nutritive disorders and characterised on the one hand by a feeling of pain and a particular mode of reaction for the whole of consciousness (psychical neuralgia) and on the other by the difficulty of psychical movements (instincts, ideas), and finally, by their inhibition."[1]

I should be loth to incur the reproach of extracting from the facts more than they contain, and of securing unity no matter at what cost. But it follows from the foregoing that if the affective state is not everywhere and always the original state, it is at least most frequently so. Besides, it is intimately connected with trophic disorders which are fundamental, so that we may reach the same conclusion by a different way. Dumas (*loc. cit.*, p. 113 et seq.) has insisted on the depressing effects of paludism, on the torpor, the physical and moral apathy of the inhabitants of Sologne, Dombes, Maremma, and other regions infested with malaria, which may be epitomised in two words, despondency and resignation. These effects are all in favor of the organic origin of melancholic maladies.

The special study of the anomalies of pleasure and of pain is not only important in itself. The formula generally accepted since Aristotle, which couples pleasure with what is beneficial and pain with what is detrimental, is subject to many exceptions in practice. Perhaps the establishment of a pathological group in the study of pleasure and pain, will enable us to resolve some of the difficulties of this subject and prevent the rule and the anomalies from being placed on the same plane and from being unduly confounded. It extricates us from embarrassing questions and furnishes a plausible explanation in a number of cases.

PARIS. TH. RIBOT.

[1] Krafft-Ebing, Vol. II., Section I., Chap. 1.

CHINESE PHILOSOPHY.[1]

INTRODUCTORY.

CHINESE philosophy is as peculiar as the Chinese language and Chinese customs, and it is difficult for Western people to understand its nature or to appreciate its paramount influence upon the national character of the Celestial Empire. It is a rare mixture of deep thought and vain speculations, of valuable ideas and useless subtleties. It shows us a noble beginning and a lame progress; a grand start and a dreary stagnation; a promising seed-time and a poor harvest. The heroes of thought who laid its foundations, were so much admired that none dared to excel them, and thus before the grandeur of the original genius which looms up in the prehistoric age, the philosophy of all later generations is dwarfed into timid insignificance.

The Chinese are naturally conservative because their written language is rigid and inflexible, rendering the task of forming new words extremely difficult. And the people who are hampered in forming new words are also hampered in their conception of new ideas and the discovery of new truths. But let us remember that this drawback of the Chinese script is only an incidental consequence of its extraordinary advantages. Consider that whatever changes there may have been in Chinese speech, i. e., in oral language, the Chinese scholars of to-day can read without great difficulty the books that were written two and one-half millenniums ago. Moreover, their ideographic script is more impressive and direct than our phonetic

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[1] The Chinese characters that appear in this article were made by Mr. H. H. Clarke of the Stationers' Engraving Company, Chicago, Ill.

method of writing in which the letters must be translated into sound before they can be understood by the reader. Dr. Morrison says in the introductory remarks to his dictionary (p. 11):

"As sight is quicker than hearing, so ideas reaching the mind by the eye are quicker, more striking, and vivid, than those which reach the mind by the slower progress of sound. The character forms a picture which really is, or, by early associations is considered, beautiful and impressive. The Chinese fine writing darts upon the mind with a vivid flash; a force and a beauty, of which alphabetic language is incapable."

But it is not the rigidity of their language alone that is at the basis of the Chinese conservatism, it is also the simplicity of the fundamental ideas of their world-view and the striking symbolism in which they are expressed and which makes it impossible for the Chinese to think in any other modes of thought than their own. The inviolable power of their tradition is further strengthened by an imperturbable patience and unbounded reverence for the sages of yore. The former renders the people submissive to many unheard-of abuses on the part of the authorities, while the latter keeps them in faithful adhesion to established conditions.

From time immemorial the highest ideal of Chinese thinkers has been to bow in modesty and submission to the insuperable grandeur of their ancient traditions. Criticism is very meek, originality of thought is strangled ere it can develop, and any attempted progress beyond the old masters appears to them as insanity. It is as if a Christian would dare to be better or wiser than Christ. In a word, the whole Chinese civilisation is saturated with the belief in the divinity, the perfection, and the unqualified excellence of its principles, doctrines, and institutions.

In the following pages we shall attempt to delineate in large outlines the philosophy that underlies the Chinese civilisation, and we hope that it will not only enable the reader to comprehend how the Chinese are hampered by their mode of notation in both their thought-symbols and their language, but that he will also learn to appreciate the causes which produce Chinese conservatism. For, indeed, there is in the Chinese world-conception so much that appeals to us as self-evident and on *a priori* consideration as a matter

of course, that we can understand how difficult it is for the Chinese to free themselves from the rigid forms of their traditions and adapt themselves to the more plastic modes of Western thought.

THE YANG 陽 AND THE YIN 陰

The ancient Chinese were distinguished by a mathematical turn of mind. For, while the literature of all other nations begins with religious hymns and mythological lore of some kind, the oldest documents of the Chinese exhibit arithmetical devices, two among which are known as the 河圖 *Ho T'u*[1] and the 洛書 *Loh shu*, "the map of the Ho,[2] or [yellow] River" and "the writing of the (river) Loh."

All Chinese scholars who have attempted to reconstruct the map of the Ho and the writing of the Loh agree in adopting a dualistic system, which conceives the world as the product of 陽 YANG and 陰 YIN.[3] Yang means "bright," and Yin "dark." Yang is the principle of heaven, Yin is the principle of earth. Yang is the sun, Yin is the moon. Yang is, as we should say, positive; Yin is negative. Yang is, as the Chinese say, masculine and active; Yin is feminine and passive. The former is motion, the latter is rest. Yang is strong, rigid, lordlike; Yin is mild, pliable, submissive, wifelike. Yang was originally represented by a small, bright circle (○), Yin by a small, dark circle (●), but in their combinations these symbols were replaced by full and broken lines, "⚊" and "⚋."

The symbols of Yang and Yin are called the two *I* or "elementary forms," and the four combinations of the two *I* in twos are called the four Figures or Siang.[4] They are as follows:[5]

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[1] The *spiritus asper* in T'u indicates that the T must be pronounced with a certain vigor or emphasis. French and German sinologists spell "Thu," which transcription, however, is misleading in English.

[2] *Ho*, the River, stands for *Hoang Ho*, the yellow river.

[3] 陽 shows the symbols "place" and "spreading"; 陰 is "the shady side of a hill."

[4] See Mayer's *Chinese Reader's Manual*, pp. 293 and 309.

[5] *Yih King*, App. V., Chap. VII.

the great Yang the small Yin the small Yang the great Yin

Groups of three or more elementary forms are called *Kwa*[1] 卦

The eight possible trigrams, or permutations of three I, possess their own names and meanings, which (according to Legge) are as follows:

KWA	NAMES		STANDING FOR	REPRESENTED BY THE
1 	chiên.	Heaven or sky.	Strength.	Horse.
2 	tui.	Lake (water collected in a basin).	Pleasure or satisfaction.	Goat.
3 	lî.	Fire (the sun or lightning).	Brightness.	Pheasant.
4 	chan.	Thunder.	Energy or mobility.	Dragon.
5 	siuen.	Wind.	Penetration.	Bird.
6 	k'ân.	Moon, streams of water in motion, clouds, rain.	Sinking down, danger.	Pig.
7 	kan.	Mountain.	Arrest, standstill.	Dog.
8 	kw'un.	Earth.	Compliance or docility.	Ox.

All the things in the world, man included, are thought to be compounds of Yang and Yin elements. In this way the Chinese philosophy has become a theory of permutation, and the origin of all things is traced to a change in the combinations of Yang and Yin.

FUH-HI 伏羲 AND YÜ 禹

As to the map of the Ho and the writing of the Loh, we must state at once that nothing definite is known concerning their original form and significance. Only this much is safe to say, that tradition unanimously connects the former with 伏羲 Fuh-hi, the first emperor of China and the legendary founder of the Chinese civilisa-

[1] The character 卦 shows on the left-hand side "batton," on the right "to divine."

tion (about 3322 B. C., according to another calculation about 2800 B. C.), and the latter with 禹 Yü the Great (about 2200 B. C.), the founder of the second Chinese dynasty.

We are told of a great deluge that devastated the country under the virtuous Yao, the last emperor but one of the first dynasty; and that Kwen, the Minister of Works, labored in vain to control the waters. Kwen was banished for life to Mount Yü in 2286 B. C., while his duties were intrusted to his son, Yü, who at last, after nine years, in 2278 B. C., succeeded in draining the floods. Emperor Shun, the son-in-law and successor of Emperor Yao, in disregard of his own sons, raised Yü to the position of joint regent in 2224 B. C., and bequeathed to him the empire. When Shun, in 2208 B. C., died, Yü observed a three years' period of mourning, whereupon he assumed the government, in 2205 B. C.

Much may be legendary in the records of the ancient history of the Chinese, but there is no doubt that Yao, Shun, and Yü are historical personages. They represent an epoch of civilisation which, probably in more than one respect, has never been reached again by the Chinese. Public works, such as regulating the course of great rivers, were undertaken, and the sciences of mathematics and astronomy flourished. Eclipses of the sun and moon were calculated; we know that the brothers Hi and Ho observed and calculated the planetary revolutions;[1] and we possess in the Shu King documents that give evidence of manliness and moral stamina. There is, for instance, the speech[2] delivered by Yü's worthy son and successor, Ch'i, at Kan in 2197 B.C., which reminds us of Frederick the Great's famous address to his generals before the battle of Leuthen. No wonder that these days of pristine glory are still remembered in the proverbial expression, "the heaven of Yao and the sun of Shun," which denotes the highest prosperity imaginable.

If the Map of Ho 河圖 and the Writing of Loh 洛書 are not to be attributed to the Emperors Fu-Hi and Yü personally, we can safely trust the old tradition, at least so far as to say, that

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[1] Mayer's *Chinese Reader's Manual*, Part I., No. 900.

[2] *Sacred Books of the East*, III., pp. 76–78.

these two documents (whatever their nature may have been) belong to the ages represented by Fu-Hi and Yü.

THE YIH 易 AND THE KWA 卦

The ancient kwa-philosophy, as we may call the system of comprehending things as permutations of the two principles Yang and Yin, plays an important rôle in the thoughts of the Chinese people and forms even to-day the basis of their highest religious conceptions, their scientific notions, and their superstitions. With its help the origin of the world is explained, rules of conduct are laid down and a forecast of the future is made.

As to the original meaning of the kwa-philosophy, we have positive evidence of its mathematical character, not only in various suggestions of Chinese traditions, but also and mainly in the nature of the kwa themselves. It is to be regretted, however, that in times of war and civil disorder the historical connexion was interrupted. Says Chu Hi in his introduction to Cheu-tsz''s T'ai Kih T'u:[1]

"After the Cheu (dynasty) [which ruled 1122–255 B. C.] perished and Meng-Kho died, the tradition of this doctrine was not continued.

"When further the T'sin were succeeded by the Han, passing the T'sin, Sin, and T'ang, so as to arrive at our Sung [the dynasty under which Chu Hi lived] and the five planets met in the K'wei (constellation) so as to usher in an age of science and erudition, the sage [Cheu-tsz'] came."

The oldest work of Chinese literature which embodies the philosophy of Yang and Yin is the Yih King (or simply the 易 Yih), i. e., the book of permutations.[2]

In the Yih King we find the eight trigrammatic kwa combined into groups of hexagrammatic kwa, resulting in eight times eight or sixty-four permutations, every one of which has its peculiar name and significance. To the sixty-four permutations of the kwa hexa-

[1] See Gabelentz's German edition of the T'ai Kih T'u, p. 14.

[2] 經 (king) signifies a classical book of canonical authority; and 易 (yih) means "permutation"; the character shows the sun above the moon, the latter in its archaic form. The translation "change," which is commonly adopted by sinologists, does not always convey the right idea.

grams an explanatory text is added consisting of seven lines.[1] The first line, written by Wen Wang,[2] applies to the hexagram as a whole, and the remaining six, written by Cheu Kung,[3] have reference to the six sundry lines of the hexagram, counting the lowest line as the first and the topmost as the sixth. The full lines, representing Yang, are called 九 *kiu*; the broken lines, representing Yin, are called 六 *luh*.[4] There can be no doubt about it that in its present form the Yih King is chiefly used for the purpose of divination.

The most ancient commentaries of the Yih King have been appended to the book in the shape of three double and four simple additions called the Ten Wings. The first addition of two sections, called T'wan is commonly ascribed to Wen Wang, the second called Siang, to his son, Cheu Kung, while the rest belong to later periods, containing expositions ascribed to Confucius.

The Yih King is one of the most enigmatic books on earth, the mystery of which is considered by many beyond all hope of solution; and yet it exercises even to-day a greater influence over the minds of the Chinese than does the Bible in Christian countries. Its divine authority is undisputed and every good Chinese is confident that it contains the sum of all earthly wisdom. There is no Chinese scholar who cherishes the least doubt that there is any truth in science or philosophy that could not be found in, and rationally developed from, the Yih King.

The oldest mention of the Book of Permutations is made in the official records of the Cheu dynasty, which succeeded the Yin dynasty in 1122 B.C. There three versions of the Yih are mentioned. We read:

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[1] The first and second kwa are exceptions. They possess an addititional eighth line, which refers to all the six I together.

[2] *Wen* means "scholar," or "scholarly," i. e., "he who pursues the arts of peace." *Wang* means "king." Wen Wang received the posthumous title *Si Peh*, i. e., "Chief of the West." His proper name is *Ch'ang*; but as it is not respectful to use the proper name, he is commonly called "Wen Wang."

[3] *Kung* means "duke." *Cheu Kung* (i. e., the Duke of Cheu) was the fourth son of Wen Wang; his proper name is *Tan*.

[4] The original meaning of 九 *kiu* is "nine," of 六 *luh* "six."

"The Grand Diviner had charge of the rules for the three Yih (systems of permutation), called the Lien-shan, the Kwei ts'ang and the Yih of Cheu; in each of them the primary figures were eight which were multiplied in each till they amounted to sixty-four."—*Sacred Books of the East*, XVI, p. 3.

The third mentioned version of the Yih is ascribed to Wen Wang, (1231–1135 B. C.), and his son Cheu Kung (1169–1116).[1]

Wen Wang, a man of unusual piety and stern justice, was the most powerful vassal of the last ruler of the house of Yin,[2] called 紂辛 Cheu Sin, "the dissolute tyrant." When Wen Wang had excited the wrath of Cheu Sin and of his equally brutal consort, Ta-Ki, by expressing disapproval of some of their atrocities, he was imprisoned, but after three years released through the intercession of his son Fâ, afterward called Wu Wang.[3] The latter sent rich presents to Cheu Sin and with them a beautiful girl, for whose sake the tyrant gladly acceded to the requests of Fâ.[4] While in prison at Yew Li, in 1143 B. C., Wen Wang studied the hexagrams of Fuh-Hi, and comforted himself with the propitious prophecies which he believed he discovered in their mysterious lines.

When Wen Wang died, Fâ inherited his father's kingdom. Meanwhile the tyranny of his suzerain, Cheu Sin became so intolerable that even the tyrant's own brother K'i, the prince of Wêi, fled to his court and appeared before him with an iron chain round his neck. After this event no choice was left Wu Wang. He had either to betray the confidence of K'i or to resist the unrighteous tyranny of Cheu Sin. In the spring of the year 1121 B.C. he offered a solemn sacrifice to Shang Tî, the Lord on High,[5] and marched against his suzerain. He crossed the Hoang-Ho at the ford of

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[1] The ancient rulers of China are called emperors or Tî; but the rulers of the dynasty Hia preferred the more modest title of King or *Wang*.

[2] The Yin dynasty is also named Shang.

[3] Fâ, surnamed Wu Wang (i. e., the war king), was the oldest son of Wen Wang.

[4] Cheu Sin (the dissolute tyrant) is a posthumous title. His proper name is "Show." The word "Cheu" in the name Cheu Sin is not the same word as the name of the principality of "Cheu," after which the Cheu dynasty is called.

[5] 上 (shang) "above," "high in heaven," or "supreme," 帝 (tî) Lord, emperor, sovereign. The etymology of "tî" is doubtful.

Meng-tsin and gained a decisive victory in the plain of Muh. Cheu Sin shut himself up in his palace, at Luh T'ai, ordered his servants to set it on fire and died in its flames in the year 1122 B. C. Thus the Yin dynasty was superseded by the Cheu dynasty. Cheu Kung, Wu Wang's younger but more famous brother, contributed much toward the consolidation of the Cheu dynasty as chief counsellor, first of Wu Wang and then of Ch'ung, i, e., "the Perfecter," his imperial nephew and successor to the throne after Wu Wang's death.[1]

There seems to be no question that the founders of the Cheu dynasty revised and rearranged the traditional Kwa systems; and the Yih of Cheu, is according to undisputed tradition, the Book of Permutations which is extant to-day.

Tradition preserves two schemes of the eight trigrams in the shape of a mariner's compass-card, in which south is always topmost. The older scheme is ascribed to Fuh-Hi, and the later one to Wen Wang. Their arrangements are as follows:

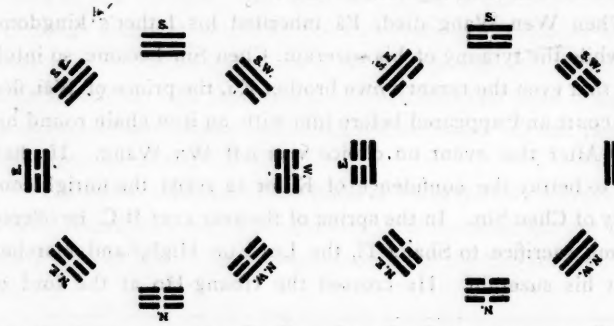

FIG. 1. THE TRIGRAM ACCORDING TO FUH-HI. FIG. 2. THE TRIGRAM ACCORDING TO WEN WANG.

Fuh-Hi's table shows the Yang and Yin symbols evenly balanced, so that each couple of opposed kwa is made up of three full and three broken lines.

We are unable to say why Wen Wang changed the more natural order of the Fuh-Hi system. Probably he argued that if the world were arranged in the evenly balanced way of the traditional scheme,

[1] See Victor Strauss's German translation of the *Shi-King*, pp. 39–44.

it would not move, but remain at rest. Thus he naturally might have come to the conclusion that change which is the condition of the actual universe can only be due to a displacement of the regularly arranged order which would represent the elements of existence in a state of equilibrium.

One of the arrangements of the hexagrams that are met with in all the larger editions of the Yih King, consists, as can be seen in the appended diagram, of a square surrounded by a circle.

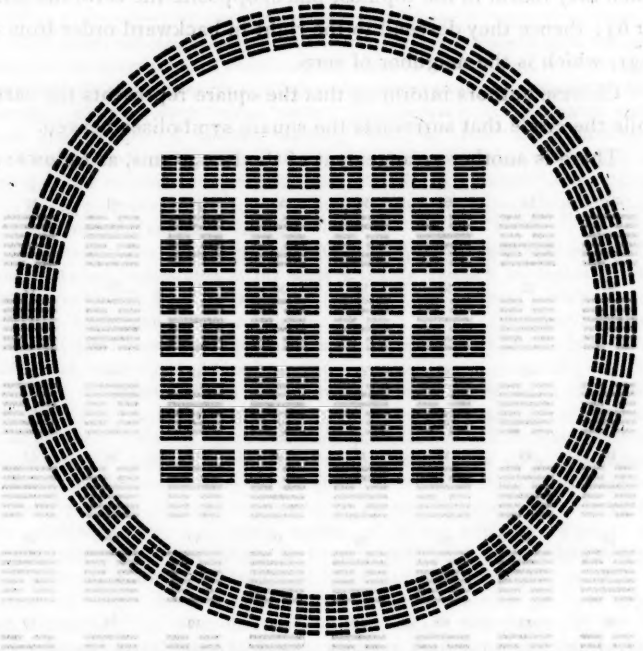

FIG. 3. THE KWA OF FUH-HI ARRANGED IN SQUARE AND CIRCLE.

In the square the sixty-four permutations of the hexagrams are arranged in the order of what may be called their natural succession; that is to say, on substituting for broken lines zero (o), and for full lines the figure "1," we can read the hexagrams as a series of numbers from o to 63, written in the binary system. The topmost figure in the left corner represents zero, i. e. oooooo; and reading from

the left to the right, we have 1, i. e. 000001; 2, i. e. 000010; 3, i. e. 000011; 4, i. e. 000100; etc., until 111111, which, in the decimal system, is 63.

The circle contains the same symbols so arranged that those which diametrically face one another yield always the sum of 63. Thus heaven, i. e. ䷀ or 63, and earth, i. e. ䷁ or zero, are, the former at the top, the latter at the bottom of the circle. Beginning with zero at the bottom, the numbers ascend from 1 to 32, after which they reach, in the topmost place, opposite the zero, the number 63; thence they descend to the right in backward order from 62 to 31, which is the neighbor of zero.

Chinese authors inform us that the square represents the earth, while the circle that surrounds the square symbolises heaven.

There is another arrangement of the hexagrams, as follows:

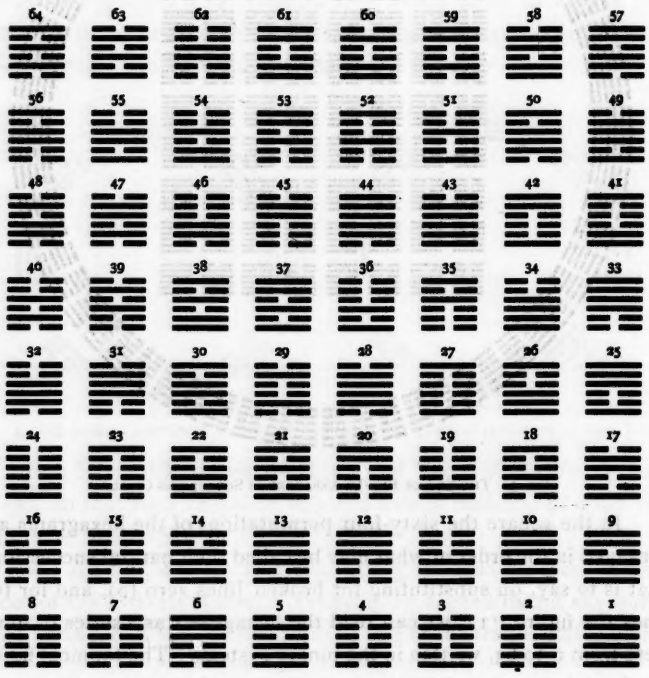

FIG. 4. THE HEXAGRAMS ACCORDING TO WEN WANG.

Beginning from the right on the bottom line, the sixty-four kwa[1] are arranged in the order of the Cheu version, ascribed to King Wen. The design exhibits in the even columns the inverse arrangement of the kwa of the odd columns, with this exception, that whenever an inversion would show the same figure, all the Yang lines are replaced by Yin lines, and *vice versa*.

Thus the hexagram No. 44, called "Kân" ䷳ is the inverted hexagram No. 43, called "Kwâi" ䷪, while "K'ien," ䷀ in No. 1, is changed into "Kw'an" ䷁ in No. 2.

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[1] The names and significance of the several hexagrams depend upon the combination of the two trigrams of which each one consists. Thus, No. 1 is "sky" upon "sky," viz., the active principle doubled, which means great and successful display of energy. No. 2 is "earth" upon "earth"; the receptive principle doubled, which means, great receptivity, fertility, stability. No. 3 is "rain" above "thunder," means fulness, boding prosperity to those who are constant, but threatening impending danger to those who venture to move, etc. No. 49 is "water" above "fire," which means contrasts that confront one another; to boil; to transform (implying that fire changes the nature of water).

The names of the hexagrams, according to a Japanese authority (in the Taka-shima-ekidan), interpreted in the sense given by Western sinologists, mainly by Harlez (in his Yih King), are as follows: 1. *K'ien*, sky, success; 2. *kw'un*, earth, stability; 3. *chun*, fulness; 4. *meng*, infancy, growth; 5. *hsü*, expectancy, danger; 6. *song*, litigation, lawsuit; 7. *szé*, an army or a commander; 8. *p'i*, friendship; 9. *hsiâo chuh*, being clouds but no rain, little progress; 10. *lî*, to march; 11. *T'âi*, penetration, no obstruction; 12. *p'ei*, obstruction, to be besieged; 13. *thong zhin*, union, fellowship; 14. *tai yu*, great, power; 15. *k'iĕn*, condescension; 16. *yû*, satisfaction, grandeur, majesty; 17. *sui*, faithfulness, obedience; 18. *ku*, care, business, agitation; 19. *lin*, dignity, authority; 20. *kwen*, manifestation, show, appearance; 21. *shî hŏh*, slander, censure; 22. *pî*, embellishment, flash of light; 23. *poh*, oppression, deprivation; 24. *fûh*, reaction, return; 25. *wû wang*, openness, sincerity; 26. *tai ch'uh*, accumulation; 27. *î*, to sustain, to feed; 28. *ta kwo*, rising of the great; 29. *k'an*, difficulties; 30. *lî*, brilliancy; 31. *hien*, harmony; 32. *hang*, endurance; 33. *t'un*, to retreat, to live in obscurity; 34. *ta chuang*, great strength; 35. *ts'in*, to advance; 36. *ming î*, descent, eclipse, stars; 37. *kiâ zhin*, family; 38. *k'wei*, opposition, contrariety; 39. *kiĕn*, difficulty; 40. *kieh*, escape, deliverance; 41. *sun*, to abate, to lessen; 42. *yîh*, aggrandizement, gain; 43. *kuâi*, dispersion, distribution; 44. *k'ĕû*, to meet; 45. *tsui*, to assemble; 46. *shang*, to ascend; 47. *k'wan*, distress; 48. *tsing*, a well; 49. *koh*, water over fire, to renew, to transform; 50. *ting*, fire over wood, caldron; 51. *chan*, thunder, terror; 52. *kan*, firmness; 53. *chien*, to inchoate, to move apace; 54. *kuei*, to give in marriage; 55. *fang*, wealth; 56. *lü*, a stranger, a traveller; 57. *sûn*, pliability, meekness; 58. *tui*, rejoicing; 59. *hwân*, to flow over, to squander; 60. *chieh*, law, moderation; 61. *chung*, the right way, in the middle; 62. *hsiâo kwó*, excess in small things; 63. *ki tsi*, consummation; 64. *wei tsi*, non-consummation.

[The translation of the names of the sixty-four kwa, as given here, only approximately agrees with the system elsewhere employed in this article.]

If regarded as binary numbers, the order of King Wen's square reads in decimal numbers as follows:

21	42	12	51	50	19	54	27
13	44	52	11	9	36	29	46
26	22	24	6	31	62	35	49
20	10	53	43	40	5	60	15
28	14	45	18	30	33	57	39
32	1	41	37	3	48	25	38
4	8	61	47	7	56	55	59
2	16	13	58	17	34	0	63

THE MILFOIL 蓍 AND THE SPIRIT TORTOISE 神龜

The divining stalks[1] and the tortoise-shell have been in use in China for the purpose of divination from time immemorial, for the practice of divination is mentioned in the oldest documents of the Shu King,[2] where Yü recommends "the trial by divination."

The outfit for divining 筮 by the stalks of 蓍 the divining plant (*Ptarmica Sibirica*) consists of six little oblong blocks (like toy construction-blocks) being, on two sides, divided by an incision after the pattern of the broken line of Yin and smooth like Yang lines on the two remaining sides; further, of fifty wooden stalks, a little thicker than knitting-needles. The six blocks represent Yang lines if the smooth side, and Yin lines if the incision, is uppermost. The method of divination as prescribed by the Book of Eki in the Takashima Ekidan (Keigyosha, Tokio, 1895), is as follows:

"First of all, wash your hands and mouth, clean your body, and sit perfectly aright in a quiet room, and then you may take hold of the '*sticks*' very reverently. Fifty sticks make a complete set, and it must be remembered that they are the holy implements which reveal the will of the Almighty through their mathematical changes. Take out any single stick and let it stand in the stickholder,

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[1] *Shi tsao* 筮草 the "divining plant" is a species of *shi* 蓍 "milfoil" the same plant which is cultivated at the tomb of Confucius. The symbol "milfoil" is composed of the three characters "plant" on the top, "old man" in the middle, and "mouth" or "to speak" at the bottom.

[2] Part II., Book II., § 2; *Sacred Books of the East*, III., p. 50.

which is to be placed on the centre of the table. This particular one is referred to the '*Great Origin.*' Hold the lower ends of the remaining forty-nine in your left hand, and slightly dovetail the upper ends. Apply your right-hand fingers to the middle of the sticks, the thumb being nearest to you or from inside, and the other fingers to be applied from outside. Lift the whole thing above your forehead. Now turn your sole attention to the affair to be divined, close your eyes, suspend your breath, make yourself solemn and pure, be sure that you are in interview with the Almighty to receive his order, and further, do not diversify your thoughts to anything else. At the moment when your purity of heart is at its apex, divide the sticks into any two groups with your right-hand thumb. The division must not be voluntary.

"It must be observed here that the moment when the purity of one's heart is at its apex is, in other words, the moment when one communicates with the Almighty. The feeling at the moment of the communication is impossible to describe, being like that which one feels when electric currents flow through his limbs. It is absolutely necessary that one shall divide his sticks at the very instant when he feels the feeling specified. This point of communication baffles every trial of description, the only way of acquiring the exact idea being through a continued practice and consequent dexterity of the student.

"Now, the set of the sticks is in two groups, which correspond to the '*Heaven and Earth*,' or '*Positive and Negative*,' in the terms of the '*Eki*.' Place the right-hand group on the table, and take out one from the group. This one is to be held between the ring finger and the little finger of the left hand; the figures being that of the '*Three Figures*,' namely, '*Heaven, Earth, and Mankind*.' Count the left-hand group with your right hand: it is to be counted in cycles, each cycle being four times two by two, or eight sticks per cycle. When any number of cycles has been finished, there will remain a number of sticks less than eight, including the one on the little finger. This remainder gives a complement of the destined diagram.

"If one remains you have 'Ken' (☶).

"If two remain you have 'Da' (☱).

"If three remain you have 'Ri' (☲).

"If four remain you have 'Shin' (☳).

"If five remain you have 'Son' (☴).

"If six remain you have 'Kan' (☵).

"If seven remain you have 'Gon' (☶).

"If eight or naught remains you have 'Kon' (☷).[1]

"These are the eight emblems of '*Heaven*,' '*Pond*,' '*Fire*,' '*Thunder*,' '*Wind*,' '*Water*,' '*Mountain*,' and '*Earth*' in their order. The trigram corresponding to the present remainder is called the '*Inner Complement*,' and is to be placed at the

[1] Here the Japanese pronunciation of the Chinese terms is preserved.

bottom of the diagram. The above-stated process is now to be repeated, and the trigram corresponding to the second remainder is called the '*Outer Complement*,' and is to be placed at the top of the diagram. Now you are in possession of a complete diagram of six elements.

"The destined diagram is now before you; the only thing left is to observe the change in the 'elements.'[1] The method of dealing out the sticks is the same as before, except the mode of counting them. Here each cycle consists of six sticks, so that three times two by two are to be counted per cycle. The remainder thus obtained expresses the element to be chosen. If your remainder is one, you have obtained the first element of the diagram; if two, the second element, etc. The order of the elements is numbered from below, that is to say, the bottom element is the first, and the top one the sixth.

"You have now thus obtained an element of a diagram."

Having thus obtained a definite element in a definite hexagram, the diviner turns to the book and reads the sentence belonging to it. This sentence is to him the oracle that he receives in reply to his question, and must be interpreted in the light of the expositions given concerning the whole hexagram. The two most important lines in the hexagrams are the second and the fifth lines, because they constitute the centre of the two trigrams of which the whole is composed. The fifth stroke, representing the efficacy of the upper or heavenly power, is always favorable, and wherever it is obtained, it bodes to the divining person luck and unfailing success.

Divination by the tortoise-shell is in principle the same. In the empty shell of the sacred tortoise, *Shan Kwei*,[2] which is a small species of *Emys*, three coins are shaken and thrown out in a dice-like manner. According to their showing heads or tails, an element of one of the sixty-four hexagrams is determined, and from a contemplation of the sentence attached to the element of the hexagram, as applied to the given situation, the outcome of the proposed action is anticipated.

The Chinese conception of the spirituality of the divining stalks and the tortoise shell is expressed in the third Appendix of the Yih King as follows:

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[1] Viz., "of the particular line in the hexagram."

[2] 神 *shan*, consists of "divine" and "to extend"; while 龜 *kwei*, is "intended to represent the general appearance of a tortoise" (Williams).

"Therefore heaven produced the spirit-like things,[1] and the sages took advantage of them. (The operations of) heaven and earth are marked by (so many) changes and transformations; and the sages imitated them (by the means of the Yî). Heaven hangs out its (brilliant) figures from which are seen good fortune and bad, and the sages made their emblematic interpretations accordingly."

Divination is practised officially in China by imperial diviners. We read in the counsels of Yü that Shun submitted the question of succession to divination, and abided by its decision in somewhat the same way as among the Israelites problems of grave importance were settled by consulting the oracle of Urim and Thummim.

The seventh division of the Great Plan gives the following instruction to rulers concerning the practice of divination:

"Officers having been chosen and appointed for divining by the tortoise-shell and the stalks of the milfoil are to be charged to execute their duties. They will predict rain, clearing up, cloudiness, want of connexion, and disturbances, through the inner and outer diagrams.

"In all there are seven (examinations of doubt): five given by the shell, and two by the stalks; and through them all errors can be discovered.

"The officers having been appointed, when the divination is inaugurated, three men are to interpret the indications, and the consensus of two of them is to be followed.

"When you have doubts about any great matter, consult with your own mind; consult with your high ministers and officers; consult with the common people; consult with the tortoise-shell and divining stalks.

"If you, the shell, the stalks, the ministers and officers, and the common people, all agree about a course, it is called a great concord, and the result will be the welfare of your person and good fortune to your descendants.

"If you, the shell, and the stalks agree, while the ministers and officers and the common people oppose, the result will be fortunate.

"If the ministers and officers, with the shell and stalks, agree, while you and the common people oppose, the result will be fortunate.

"If the common people, the shell, and the stalks agree, while you, with the ministers and officers, oppose, the result will be fortunate.

"If you and the shell agree, while the stalks, with the ministers and officers, and the common people, oppose, internal operations will be fortunate, and external undertakings unlucky.

"When the shell and stalks are both opposed to the views of men, there will be good fortune in being still, and active operations will be unlucky."

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[1] The divining stalks and the divine tortoise-shell

In justice to the original Chinese conception of divination we must state that it was not intended to discover future events, but to ascertain whether or not certain plans contemplated for execution would be propitious. The tortoise-shell and the stalks are called spiritual, not because they were supposed to be animated by spirits, but because, like books and pens, they can be employed for the fixation and clarification of thought. Sz' Ma, the most skilful diviner in the time of Ts'in (fifteenth century), is reported in the Lin Chi of the Ming dynasty to have said to Shao P'ing:

"What intelligence is possessed by things spiritual? They are intelligent (only) by their connexion with men. The divining stalks are so much withered grass; the tortoise-shell is a withered bone. They are but things, and man is more intelligent than things. Why not listen to yourself instead of seeking (to learn) from things?"

Spiritual accordingly does not mean possessing spirit in the sense of being animated; it means that which is significant or is possessed of meaning.

THE MAP OF HO 河圖 AND THE WRITING OF LOH 洛書

The first authentic passages in which 河圖 the map of Ho and 洛書 the writing of Loh are mentioned, date as far back as the age of Confucius. We read in the Yih King, Appendix III., 73:

"The Ho gave forth the map, and the Lo the writing."—*S. B. E.*, XVI., p. 374.

In the Lun Yü (the Confucian Dialogues), V., 7, we read that Confucius said in an hour of dejection:

"The bird Feng does not longer reappear, from the river no map comes up again:[1] I am disappointed in my expectations."

The first author who appears to have given a definite shape to the legends of the map of Ho and the writing of Loh is K'ung Ngan-Kwoh, a descendant of Confucius (second century, B.C.). He

[1] This means in other words that divine revelation by a direct supernatural interference has ceased. The bird Feng (see Fig. 6) is like the Phœnix a mythical creature whose appearance is said to announce great events. *Feng*, the Chinese Phœnix, and *lung*, the dragon, are favorite subjects of Chinese artists. The female of the Phœnix is called *Hwang*, hence the generic term *Feng-Hwang*, which is the emblem of conjugal happiness. *Lung*, the dragon (see Fig. 5), is the emblem of power; hence it is the imperial coat-of-arms.

speaks of the dragon-horse that emerged from the waters of the Yellow River and presented on its back an arrangement of symbols, whence the divine ruler Fuh-Hi, derived his philosophy. Concerning the writing of Loh, K'ung Ngan-Kwoh adds that while Yü was engaged in draining the flood a spirit tortoise appeared to him which "carried on its back a scroll of writihg and a system of divisions, in both respects exhibiting the numbers up to nine."

There is but one celebrated Chinese scholar, Ow-yang Sin, who ventured to express disbelief in the legend while the schoolmen of the Sung dynasty devoted themselves to a reconstruction of the

FIG. 5. LUNG, THE DRAGON. (As it appears in the imperial standard.) The lung is "the chief of scaly beings." It symbolises the watery principle of the atmosphere. Cosmogonists mention four kinds. In addition we read of the yellow dragon (the same that emerged from the river Loh) and the azure dragon.

FIG. 6. THE BIRD FENG. (After a Chinese drawing. Reproduced from the *Chinese Repository*.)

map of Ho and the writing of Loh. The schemes that have gradually been accepted are the two diagrams reproduced on p. 206 from a Chinese edition of the Yih King. They were elaborated by Ts'ai Yuen-Ting who lived under the Hwei Tsung dynasty (1101–1125 A. D.).

The Ho T'u, or map of the Ho, according to Ts'ai Yuen-Ting, shows the odd numbers 1, 3, 5, 7, and 9 in white dots or Yang symbols, and the even numbers 2, 4, 6, 8, and 10 in dark dots or Yin symbols. (See Fig. 7.) This is based upon the theory of the Confucian commentary of the Yih King, which reads as follows:

"The number 1 belongs to heaven; to earth, 2; to heaven, 3; to earth, 4; to heaven, 5; to earth, 6; to heaven, 7; to earth, 8; to heaven, 9; to earth, 10.

"The numbers belonging to heaven are five, and those belonging to earth are five. The numbers of these two series correspond to each other (in their fixed positions), and each one has another that may be considered its mate. The heavenly

numbers amount to 25, and the earthly to 30. The numbers of heaven and earth together amount to 55. It is by these that the changes and transformations are effected, and the spirit-like agencies kept in movement."

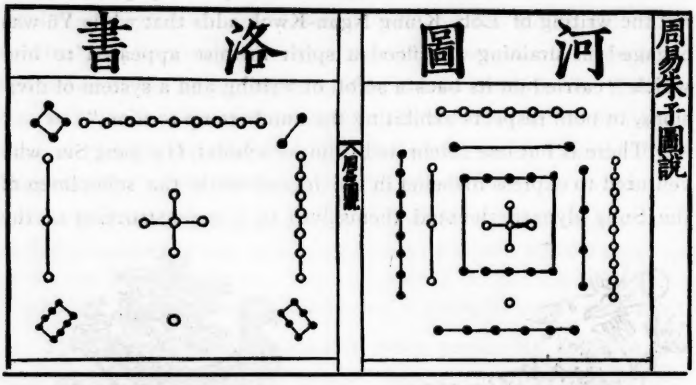

FIG. 8. THE WRITING OF LOH. FIG. 7. THE MAP OF THE HO.
(According to Ts'ai Yüang-ting; reproduced from a Chinese edition of the Yih King.)

The arrangement of the twenty-five positive or Yang and thirty negative or Yin elements, is such as to make five the difference in each group of dots. When we substitute for Yang +, and for Yin —, the Map of the Ho appears as follows:

	+7−2 =+5	
−8+3 =−5	−10+5 =−5	+9−4 =+5
	−6+1 =−5	

The writing of Loh, reproduced (Fig. 8) from the same source, consists of a magic square as follows:

4	9	2
3	5	7
8	1	6

The sum of each line of three numbers in any direction, vertically, horizontally, and diagonally, is fifteen.

Although these two arithmetical devices of the map of Ho and the writing of Loh according to Ts'ai Yuen-Ting are spoken of as commonly accepted, we find another and almost more popular scheme of unknown origin and perhaps of greater antiquity, according to which the map of Ho on the back of the river-horse is said to exhibit the eight kwa, as represented in the adjoining illustration (see Fig. 9), and the writing of Loh on the back of the tortoise is identified with the five elements (see Fig. 10).

The inscription above the dragon horse reads from the right to the left "Lung ma fu t'u," i. e. dragon horse carrying map.

FIG. 9. THE DRAGON HORSE CARRYING THE MAP.

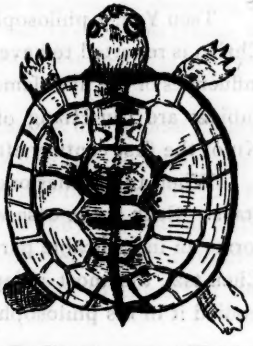

FIG. 10. THE TORTOISE WITH THE WRITING.[1]

The five elements 五行[2] according to Chinese notions, are water, wood, fire, metal, and earth.[3]

水木火金土

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[1] Drawn after the photograph of a specimen in the possession of Dr. H. Riedel. The writing of the five elements which might be similarly traced in various ways, is unduly emphasised, for the purpose of showing it at a glance.

[2] 行 *hing* = "element" exhibits two characters, "a step with the left foot,' and "a step with the right foot," which combined denote "motion." The elements, accordingly, are "the moving ones," or "the active agents."

[3] 水 *shui*, 木 *muh*, 火 *hwo*, 金 *kin*, and 土 *T'u*. *Shui* = "water" is in its original form the picture of three ripples; *muh* = "wood," the picture of a tree with its roots; *hwo* = "fire" represents an ascending flame; *T'u* = "earth" denotes the place on which to stand; and *kin* = "metal or gold" is said to contain the character *T'u* = "earth," because the metals come from the ground.

They were, in old Chinese characters,[1] written as follows:

We need little imagination to trace these characters on the shell of a tortoise, such as sketched in the drawing on page 207 (Fig. 10).

The five elements play a very important part in the thoughts of the Chinese. In their symbolical significance they represent the properties or actions that appear to be inherent in them. Their conception is of considerable antiquity, for it is mentioned in the Great Plan of the Shu King.

Tseu Yen, a philosopher who lived in the fourth century before Christ, is reported to have composed treatises on cosmogony and the influences of the five elements. Other sages who wrote on the same subject are Liu Hiang of the first century before Christ, and Pan Ku of the first century after Christ.

When an idea has once gained a foothold in the Chinese mind, it stays. Such is the case with the notion of the five elements, which forms an ineradicable part of the Chinese world-view, so that even Cheu-tsz', the most independent thinker of later generations, embodied it in his philosophy.

THE GREAT PLAN 洪範 IN NINE DIVISIONS 九疇

The Count of Chi, the grand master at the court of Shang, in the time of the tyrant Cheu Sin, said once that if ruin overtook the house of Shang, he would never be the servant of another dynasty. Having displeased Cheu Sin, he was put into prison, and when the former died in the flames of his burning palace, his conqueror, Wu Wang, released the grand master from prison, but the latter, faithful to his vow, refused to acknowledge his liberator as the legitimate sovereign of China. Wu Wang, honoring the independent spirit of the Count, allowed him to leave the country for Corea, and invested him with that territory. Hereupon the Count felt constrained to appear at the court of Cheu, when consulted by

[1] In the so-called seal characters, the forms of *shui* and *muh* appear less angular and are rounded at the corners.

Wu Wang on the principles of government, and communicated to him the 洪範 Great Plan,[1] with its nine divisions. Its translator, Professor Legge, says:

"The Great Plan means the great model for the government of the nation,—the method by which the people may be rendered happy and tranquil, in harmony with their condition, through the perfect character of the king, and his perfect administration of government."

The Great Plan is preserved among the documents of Cheu, but it is generally supposed to be of much older date. Says Legge:

"That the larger portion of it had come down from the times of Hsiâ is not improbable. The use of the number nine and other numbers, and the naming of the various divisions of the Plan, are in harmony with Yü's style and practice in his Counsels. We are told in the introductory sentences that Heaven or God gave the Plan with its divisions to Yü."

The Great Plan is interesting as a sample of Chinese philosophy. Its metaphysical basis consists in a mystical play with numbers, the reasons of which can no longer be fully appreciated; it contains a great many confused notions of physics, mixed with divination and astrology, and in addition some very practical injunctions for the moral conduct of rulers. The nine divisions[2] of the Great Plan are as follows:

1. The five elements.—They are characterised as follows:

"The nature of water is to soak and descend; of fire, to blaze and ascend; of wood, to be crooked or straight; of metal, to yield and change; of the earth, to receive seeds and yield harvests. That which soaks and descends becomes salty; that which blazes and ascends becomes bitter; that which is now crooked and now straight becomes sour; that which yields and changes becomes acrid; and from seed-sowing and harvesting comes sweetness."

2. Reverent attention to the five points of conduct.—It prescribes (1) for deportment, a reverent attitude, (2) for speech, pro-

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[1] 洪 *hung*, literally "vast, immense," but in connexion with 範 *fan*=plan, the word is commonly translated "great." The character consists of "water," which is the same radical as in the names *Ho* and *Loh*, and of "all," its original significance being "inundation." See Williams, *Syllabic Dictionary of the Chinese Language*, p. 236.

[2] 疇 (*ch'eu* = division) consists of "field" and "long life."

priety, (3) for seeing, clearness of vision, (4) for hearing, distinction, (5) for thinking, acumen. By the observation of these five points of conduct will be insured (1) gravity, (2) decorum, (3) circumspection, (4) discernment, (5) wisdom.

3. Earnest devotion to the eight objects of government.—They are (1) the provision of food for the people, (2) the acquisition of wealth, (3) the performance of sacrifices, (4) the regulation of labor, (5) the organisation of instruction, (6) the suppression of crime, (7) the entertainment of guests, and (8) the maintenance of the army.

4. The five arrangers of time.—They are (1) the year, (2) the moon, (3) the sun, (4) the planets and the zodiacal divisions, and (5) calendar calculations.

5. The ideal of royal perfection.—It is characterised in the following lines:

"Without deflection, without halting,
Pursue the royal righteousness.
Without selfish preference,
Pursue the royal way.
Without selfish prejudice,
Pursue the royal path.
Avoid deflection, avoid partiality;—
Broad and long is the royal way.
Avoid partiality, avoid deflection;—
Level and easy is the royal way.
Avoid perversity, avoid one-sidedness:—
Correct and straight is the royal way.
(Ever) seek for this perfect excellence,
(Ever) turn to this perfect excellence.

"This ideal of royal perfection is unalterable and implies a command;—yea, it is a command of the Lord on High.

"All the multitudes of the people, instructed in this ideal of perfect excellence, will, by carrying it into practice, partake of the glory of the Son of Heaven. They will say: 'The Son of Heaven is the father of the people, and the sovereign of all nations under the sky.'"

6. The three virtues of a ruler are righteousness, severity, and clemency. The first must be practised in times of tranquillity, the second serves to put down disorder, and the third applies to high-minded persons.

7. The examination of doubts prescribes the directions of divination, as explained above. (See p. 203.)

8. The eight ways of verification are astrological rules for the prevention of misfortunes. Rain, sunshine, heat, cold, and wind must be seasonable, lest evil originate. Gravity in deportment produces rain, propriety sunshine, prudence heat, circumspection cold, and wisdom wind, each in season. The king should examine the year, the ministers the months, the officers the days, in order to insure peace and prosperity. If the seasonableness is interrupted, there will be failure of crops and misgovernment. If great men are kept in obscurity, there will be unrest. The chapter concludes: "The stars should be observed by the people at large. Some stars love wind, and others love rain; the courses of the sun and moon determine winter and summer. The way in which the moon follows the stars produces wind and rain."

9. The five sources of happiness are (1) long life, (2) riches, (3) health and equanimity, (4) virtue, and (5) obedience to the will of heaven; and the six sources of misery are (1) shortness of life, (2) sickness, (3) anxiety, (4) poverty, (5) wickedness, and (6) lack of character.[1]

In spite of its lack of system and its diverse aberrations from the straight path of sound logic, the Great Plan has exercised, on account of its moral ingredients, a beneficial influence upon the development of China. Yet even here there is a drawback, in so far as the basis of Chinese ethics consists merely in reverence for the past, for parents, and for authority in any form; it lacks the most essential elements that give character to conduct, which are independence of thought, the courage of individual responsibility, and bold progressiveness.

THE T'AI KIH, 太極 THE ULTIMATE GROUND OF EXISTENCE.

The insufficiency of the dualism which finds expression in this contrast of the Yang and Yin principles, must have made itself felt

[1] It is hard to understand why in one case there are five, and in an other six sources.

very early, for the Chinese philosophy, as it appears in all the classics, exhibits a decided tendency towards monism. The Yang and Yin are thought to have originated in a process of differentiation from the T'ai Kih, which is "the grand origin," *der Urgrund*, the source of existence; Gabelentz translates it, *das Urprinzip*, Legge and other English sinologists, "the grand terminus," or "the grand extreme." Its symbol is a circle, thus ○.

The word T'ai, 太 "great" or "grand," is akin to Ta, 大 "great" or "large"; it implies that the greatness is not of size, but of dignity.

Gabelentz defines the word 極 Kih[1] as follows:

"Kih originally signified, as is indicated by its radical (which is No. 75, 'tree,' or 'wood'), the ridge-pole in the gable of a house. Because it is the topmost part of the building, the term is used of all topmost and extreme points. Since we cannot go beyond the top of the gable, but only cross over to descend on the other side of the roof, Kih means 'goal,' or 'turning-point.' This latter meaning implies the idea of neutrality, which is neither on this nor on that side. As is well known, the Chinese words possess the functions of various parts of speech. Thus Kih, as adverb, means 'very, highly, extremely'; as a verb, 'to reach the goal, to exhaust.'"

The T'ai Kih 太極 is not mentioned in the body of the text of the Yih King, but is commonly believed to be implied in its secret teaching. This opinion appears to have been established as early as the time of Confucius, who is reported to have said:

"Therefore in the Yih is contained the great origin, which produced the two elementary forms [viz., Yang and Yin]. The two elementary forms produced the eight trigrams. The eight trigrams served to determine good and evil, and from their determination was produced the great world."—*Yih King*, App. III., §§ 70–71.

Legge criticises the author of this paragraph, because there is no way of deriving the full and broken lines, representing Yang and Yin, from the circle, and we grant that there is a gap here. The transition from the Yang-and-Yin dualism to the monism of the T'ai Kih did not find its appropriate symbol. Nevertheless, we can understand that the idea necessarily originated. Wang Pî,[2] a cele-

[1] See also Williams, *S. D. of the Ch. L.*, p. 393.

[2] Although Wang Pî died at the early age of twenty-four years, his authority in the mystic lore of the Yih King was so great that he is looked upon as the founder of the modern school of divination.—Mayer's *Chinese Reader's Manual*, *l. l.*, No. 812.

brated scholar of the Wei dynasty (born 225 A. D.), (as quoted by Legge, *ib.*) says:

"Existence must begin in non-existence, and therefore the Grand Terminus produced the two elementary forms. Thâi *K*'î [viz. T'ai Kih, the grand terminus] is the denomination of what has no denomination. As it cannot be named, the text takes the extreme point of anything that exists as an analogous term for the Thâi *K*'î.'

Professor Legge adds:

"Expanding Wang's comment, Khung Ying-tâ says: 'Thâi *K*'î [viz. T'ai Kih] means the original subtle matter, that formed the one chaotic mass before heaven and earth were divided;' and then he refers to certain passages in Lâo-tsze's Tâo-Teh-King, and identifies the Thâi *K*'î with his Tâo. This would seem to give to Thâi *K*'î a material meaning. The later philosophers of the Sung school, however, insist on its being immaterial, now calling it lî, the principle of order in nature, now tâo, the defined course of things, now Tî, the Supreme Power or God, now shan, the spiritual working of God. According to *K*'hang-tsze [Confucius], all these names are to be referred to that of 'Heaven,' of which they express so many different concepts."

We here reproduce a diagram of the evolution of the Kwa from the Great Extreme, which, so far as we know, has never been reproduced in any Western translation of the Yih King.

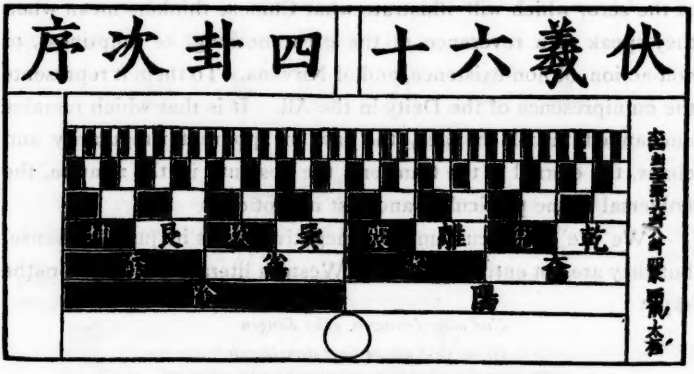

FIG. 11. THE DESIGN OF KWA-EVOLUTION FROM THE GREAT EXTREME.
(From a Chinese edition of the Yih King.)

The eight characters of the title in Fig. 11 read from the right to the left:

伏 Fuh 羲 Hi's 六 six- 十 ty 四 four 卦 Kwa 次 serially (or in their development) 序 represented.

The marginal notes from below upward read "the great extreme," "the two *I*" (or primordial forms), "the four Siang or figures," "the eight kwa," "the sixteen kwa," "the thirty-two kwa," "the sixty-four kwa."

The inscriptions in the two large black and white rectangles immediately above the circle read from the right to the left "yin" and "yang," in the second line from below consisting of two black and two white rectangles, "the great yin," "the small yang," "the small yin," "the great yang," in the third line "ch'ien, tui, lî, chan, siuen, k'ân, kan, and kw'un," which are the names of the eight Kwa, as quoted above. The thirty-two Kwa have no names. The names of the sixty-four hexagrams are written in the Chinese original over the small sixty-four rectangles at the top. They are here omitted because they would have appeared blurred in the present reproduction, which is considerably reduced.

If we fold the diagram in the middle we find that the yin and yang differentiations of the great origin cancel one another and the whole world sinks back into nought. This symbolises the omneity of the zero, which will illustrate what Chinese thinkers mean when they speak with reverence of the great nothing, of emptiness, of non-action, of non-existence, and of Nirvâna. To them it represents the omnipresence of the Deity in the All. It is that which remains unchanged in all changes, the law in apparent irregularity and chaos, the eternal in the transient, the absolute in the relative, the universal in the particular, and rest in motion.

We are not accustomed to negative terms in just this sense, but they are not entirely absent in Western literature. Thus Goethe says:

> "*Und alles Drängen, alles Ringen*
> *Ist ew'ge Ruh' in Gott dem Herrn.*"
> [Yet all the strife and all resistance
> In God, the Lord, 's eternal rest.]

THE MONISM OF CHINESE PHILOSOPHY, OR CHEU-TSZ''S 周子 PHILOSOPHY.

The monism implied in the unitary and ultimate principle of the T'ai Kih was worked out by Cheu Tun-i, commonly called Cheu-

tsz', i. e. Cheu the Sage, who lived 1017–1073. We do not hesitate to say that Cheu-tsz' is the first systematic thinker of China; he certainly deserves the honorary title, Tao-Kwoh-Kung, "Prince in the Empire of Reason," conferred upon him after death. Lao-tsz' may be deeper, Confucius more influential, Mencius more versatile, but none of them is more methodical, none of them is more precise and clear in comprehension than Cheu-tsz', and there is only one who, in this particular line, is his equal: his great disciple, Chu Hi.

Cheu-tsz' and his school have systematised and completed the philosophical world-conception of the Chinese. Whatever the ancient traditions may have been, they are now understood in China as interpreted by Cheu-tsz' and Chu-Hi.

Cheu-tsz' has written a famous booklet, *T'ai Kih T'u*, or the diagram of the Great Origin, which is excellently translated into German by Georg von der Gabelentz.[1]

Cheu-tsz' has written a great number of works, but besides the T'ai Kih T'u, there is one other booklet only that has come down to our times. This is the 通書 *T'ung Shu*,[2] or "general treatise," which found an expositor in Chu-Hi (1130–1200 A. D.). The first sentence of the *T'ung Shu* reads:

誠者聖人之本

"Truth fulness[3] [is] the holy man's root."

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[1] *T'ai Kih T'u* 太極圖 *des Tscheu Tsi, Tafel des Urprincipes mit Tschu-Hi's Commentare.* Dresden, 1876.

The *T'ai Kih T'u* is the first chapter of the *Sing ti ta tseuen* (literally, "nature principle in full completeness," or, better, "philosophical encyclopædia") published in 1415 by the third sovereign of the Ming dynasty.

[2] 通 *T'ung*, general, universal, abstract, 書 *Shu*, writing, treatise, book. The *T'ung Shu* is the second chapter of the *Sing ti ta tseuen.*

When at the request of Emperor Kanghi an abridged edition of the philosophical encyclopædia was published in 1717, both treatises of Cheu-tsz' were again embodied in the collection in their complete form together with Chu-Hi's annotations. This proves the high esteem in which these two thinkers are held in China, and, indeed, their opinions are recognised as the standard of Chinese orthodoxy.

[3] The second word, 者, *che*, means "thing," or "substance"; it changes its preceding word into a noun, just as does the English word "one" in such clauses

What a deep and after all clear and true idea is expressed in these simple words! And yet Cheu-tsz''s treatise will be disappointing to a Western reader, for in the progress of his exposition our philosopher interprets virtue in terms of the Yang and Yin system. He says in §2:

"Great is the Ch'ien's 乾 origin. All things thence derive their beginning (It is) Truth's source indeed!"

乾 Ch'ien is the first combination of three Yang elements, (☰), and stands in contrast to 坤 Kw'un (☷), the pure combination of three Yin elements; the former symbolises "heaven, virile strength, manhood, creative power"; the latter, "earth, stability, womanhood, productiveness." This is one striking instance, among innumerable others that can be found in Chinese literature, of how deeply even the most powerful minds, with the sole exception of Lao-tsz', are entangled in the Yang and Yin philosophy that looms up at the mythical beginning of Chinese civilisation and still rules the thought of the Celestial Empire to-day!

Cheu-tsz' condenses the contents of his treatise on the Grand Extreme in a diagram which we here reproduce. (See Fig. 12, p. 217.)

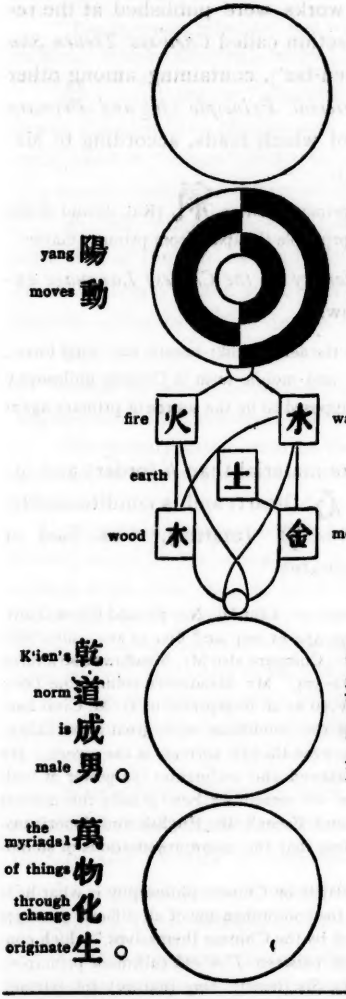
Thomas Taylor Meadows says of Cheu-tsz' in his book, *The Chinese and Their Rebellions*, p. 358.

"It is in the spirit of coalescence, and with a full personal faith in a virtual identity of the teachings of the Sacred Books, that all Cheu-tsz''s annotations and commentaries were conceived. This circumstance, which rendered it unnecessary for his countrymen, in adopting his views, to discard any part of what they had long so highly esteemed; together with the fact that his style combined, in a wonderful degree, simplicity with completeness and lucidity with eloquence, procured unmistakable supremacy for his writings soon after his death; and constituted him the definitive fashioner of the Chinese mind."

CHU HI'S DOCTRINE OF LI 理 AND K'I 氣 THE IMMATERIAL PRINCIPLE AND PRIMARY MATTER.

The mantle of Cheu-tsz' fell upon Chu Hi, also called Chu Fu Tsz', who lived 1130–1200 A. D. In his exposition of the clas-

as "the true one," "this one," or "that one." The first word means "truth," or "truthful." Accordingly the two words mean "the truth essence," the most appropriate translation of which seems to be "truthfulness."



EXPLANATIONS:

Cheu-tsz' says in the T'ai kih t'u:

§ 1. "Having no cause (*Kih* = principle, origin, limit), therefore the grand (original) cause."

[This statement may be compared to Spinoza's theory of the uncaused *causa sui*.]

§ 2. "The grand cause moves, thus producing Yang. Having reached the limit, however, it rests. Resting it produces Yin. Having rested to the limit again, it moves. Once moving, once resting; one state being conditioned by the other. In separation it is (here) Yin, in separation it is (there) Yang. Thus the two fundamental forms (viz. ⚊ and ⚋) are fixed."

§ 3. "Yang changes, Yin is added. Thus are produced water, fire, wood, metal, and earth. The five kinds of weather are distributed. The four seasons come forth."

[Fire and wood belong to the Yang, water and metal to the Yin; while earth, standing in the centre, is neutral.]

§ 4. "The five elements if united are Yin and Yang. Yin and Yang if united are the grand cause (*Kih*). The grand cause is without cause. The five elements receive at their origin, each one its own nature."

[The circle indicates that the five elements, when combined, can be regarded as magnitudes of plus and minus which in their sum equal the zero of the T'ai kih.]

§ 5. "The truth of that which has no cause, the efficacy of the Two (viz. the two forms ⚊ and ⚋) and of the Five (viz. the five elements) in a wonderful way, now combine and now separate. The K'ien's (☰) norm is male, the Kw'un's (☷) norm is female. Both aspirations quicken one another, and through transformations they produce all things. All things are produced in a process of production. Thus change and transformation are infinite."

[1] The "myriads of things" is a common phrase in Chinese, denoting the Universe.

太極圖

FIG. 12. CHEU-TSZ''S DIAGRAM OF THE GREAT ORIGIN. [After Von Gabelentz.]

sics and of Cheu-tsz''s works, Chu Hi[1] leaves no doubt about the monism of his philosophy. His works were published at the request of Emperor Kanghi in a collection called *Cheu-tsz' Tseuen Shu* (i. e., the complete writings of Cheu-tsz'), containing among other essays his treatise on *The Immaterial Principle* (*li*) *and Primary Matter* (*K'i*),[2] the first sentence of which reads, according to Mr. Meadows's translation (*l. l.* p. 373):

"In the whole world there exists no primary matter 氣 (K'i), devoid of the immaterial principle; and no immaterial principle (lí) apart from primary matter."

Williams in his *Syllabic Dictionary of the Chinese Language* explains (on p. 348) 氣 *k'i* as follows:

"Fume or vapor; . . . steam; ether; the aerial fluid; breath, air; vital force; . . . spirit, temper, feelings; a convenient and mobile term in Chinese philosophy for explaining and denoting whatever is supposed to be the source or primary agent in producing or modifying motion."

Williams adds that *k'i* is more material than *li* (order) and *tao* (reason); more external than *sin* 心 (heart) and is conditioned by its form (*hing*). It is opposed to *chi* 質 (matter),[3] "as ζωή or spirit is opposed to the body it animates."

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[1] See Mayer's *Chinese Reader's Manual*, *s. v.*, Chu Hi, No. 79, and Chow Tuni, No. 73; *Chinese Repository*, Vol. XIII., pp. 552 et seq. and 609 et seq.; also Williams, *The Middle Kingdom*, I., 683 et seq. Compare also Mr. Meadows's strictures on Dr. Medhurst's translation, *l. l.* pp. 372–374. Mr. Meadows's voluminous book is valuable in many respects. Having served as an interpreter in H. M. Civil Service, he knows the people and describes the conditions with great impartiality. However his criticism of other sinologists, even though correct, is too severe. He forgets the difficulties under which they labored and underrates the power of both religious and national prejudice. When we remember how greatly the nearest Western nations, such as the Germans and French, the English and Americans misunderstand one another, we must confess that the misrepresentations of sinologists are quite excusable.

The weakest part of Mr. Meadows's article on Chinese philosophy is what he is pleased to call "the unfailing pass-key to the comprehension of all difficult passages in the Chinese sacred books, as understood by the Chinese themselves," which consists in the proposition that the differences between *T'ai kih* (ultimate principle), *K'i* (ether), *Tao* (Logos), *Li* (world-order), *Sin* (heart), *Sing* (nature), *teh* (virtue), *t'ien* (heaven), *ming* (fate), *Ching* (sincerity) "are purely of a nominal kind."

[2] "K'i" 氣 must not be confounded with "Kih" 極

[3] The character 質 *chih* shows the radical "property" above which two taels appear. Thus it may be explained as "possessing the quality of weight."

理 *li* is defined by the same authority (on p. 519) as:

"The governing principle; that which is felt to be right and does not depend on force; reason; directing principle; principle of organisation."

性 *sing*, "nature," signifies the subjective disposition of things, never the objective phenomena of the universe. The word *sing* is composed of "heart" and "to bear, to grow," denoting that which is a manifestation of the inner character of existence.

心 *sin*, "heart," means not only the physical heart, which is regarded as the lord of the body and one of the senses, but also the core of things, as the wick of a candle, or the heart-wood of trees, and the ultimate seat of desire, the origin and source of all activity.

Chu Hi (according to Dr. Medhurst's translation) continues:

"When the primary matter is not collected and combined in form, there is no lodging-place for the immaterial principle.

"The primary matter relies on the immaterial principle to come into action, and wherever the primary matter is coagulated there the immaterial principle is present.

"No priority or subsequence can be predicated of the immaterial principle and primary matter, and yet if you insist on carrying out the reasoning to the question of their origin, then you must say that the immaterial principle has the priority; but the immaterial principle is not a separate and distinct thing; it is just contained within the primary matter, so that were there no primary matter, then this immaterial principle would have no place of attachment.

"When the primary matter is brought into being, then afterwards the immaterial principle has some place whereon to rest. In regard to great things it is seen in heaven and earth, and with respect to small, in ants and emmets."

While dwelling on the truth that the immaterial principle is inseparable from primary matter, Chu Hi yet recognises the higher dignity and priority in importance of the former, but finding no word to express precedence or superiority (i. e., priority in rank) to anteriority, (i. e. priority in time), he says:

"... And it appears to be impossible to distinguish the priority or subsequence. If you insist on it, the immaterial principle is first, but you cannot say, to-day the immaterial principle is called into existence and to-morrow primary matter; still there is a priority and a subsequence.

"Wherever the primary matter is collected, the immaterial principle is present; but after all, the latter must be considered as the chief; this is what is called the mysterious junction."

Mr. Meadows translates a passage on the problem of the priority of the *li* over the *K'i* as follows:

"Being asked whether the immaterial principle or primary matter first existed he (Cheu-tsz') said: The immaterial principle was never separated from primary matter; but the immaterial principle is what is previous to form, while primary matter is what is subsequent to form."

Chu Hi perceives that he is dealing with an abstraction of the highest kind, an abstraction of the universal; and we feel in the many repetitions which fill his treatise how he grapples with the problem, the solution of which he has in his mind without being able to find an adequate symbol to express it. Wherever he turns he sees inseparableness and distinctness. The immaterial principle is omnipresent in all things, and yet it is different from matter, in explanation of which Chu Hi says: "We must not consider the muddiness of the stream to be the water."

The *li* or immaterial principle, resembles Kant's *a priori* or the purely formal,[1] the laws of which remain true not only of this actual world of ours, but also of any possible world, and even if nothing at all existed. Chu Hi attempts to express his idea thus:

"You cannot distinguish in this matter between existence and non-existence; before heaven and earth came into being it was just the same."

The immaterial principle remains true for both existence and non-existence, but it cannot manifest itself without the existence of primary matter. Seen in this light, the last quotation will not appear contradictory to the following:

"Wherever the primary matter exists there is found the immaterial principle, and where there is no primary matter there is also no immaterial principle."

The immaterial principle is the natural order of the seasons, the principle of virtue in the moral man, the wisdom of the sage. It is, on the one hand, the mentality of sentient beings which makes comprehension possible, and on the other hand, the rationality of the universe, i. e., the cosmic order which renders the world intelligible. Chu Hi says:

[1] It is what we define in the *Primer of Philosophy* (p. 79 et seq.) as "the rigidly formal."

"That which perceives is the immaterial principle of the mind; and that which enables it to perceive is the intelligence of the primary matter."

The immaterial principle as it affects the Yang and Yin is symbolised by a circle in which light and darkness are evenly divided. Darkness contains the seed of light, and light contains the seed of darkness.

SYMBOL OF THE SOURCE OF EXISTENCE.

Chu Hi identifies the immaterial principle with Lao-tsz''s 道 Tao and with Cheu-tsz''s T'ai Kih. He says:

"The great extreme is merely the immaterial principle of heaven, earth, and all things; speaking of it with reference to heaven and earth, then the great extreme may be said to exist within heaven and earth. Speaking of it with respect to the myriad of things, then amongst the myriad of things[1] each one possesses a great extreme.

"The great extreme is not an independent separate existence; it is found in the male and female principles of nature, in the five elements, and in the myriad of things. . . . Should any one ask, what is the great extreme? I should say, before its development it is the immaterial principle, and after its manifestation it is feeling; thus for instance, when it moves and produces the male principle of nature, then it is feeling or passion.

"At the very first there was nothing, but merely this immaterial principle.

"From the time when the great extreme came into operation the myriad things were produced by transformation; this one doctrine includes the whole; it is not because this was first in existence and then that, but altogether there is only one great origin, which from the substance [abstract existence; in-itself-ness] extends to the use [to its manifestation in reality], and from the subtile reaches to that which is manifest.

"Cheu-tsz' called it the extremeless or the illimitable, by which he meant the great noiseless, scentless mystery."

By "noiseless" and "scentless" is meant the incorporeal, i.e., that which is not perceived by the senses, but can only be comprehended by the mind—as, for instance, the truth of a mathematical theorem cannot be apprehended by any one of the senses, but is a matter of pure understanding. Thus Chu Hi says:

"The immaterial principle cannot be perceived [viz., by the senses]; but, from the operations of the male and female principles of nature [viz. the purely formal

[1] See footnote belonging to Fig. 12 on p. 217.

science of Yang and Yin permutations] we become acquainted with it; thus the immaterial principle depends (for its display) on the male and female principles of nature.

"Should any one ask, what is the great extreme? I would say, the great extreme is simply the principle of extreme goodness and extreme perfection. Every man has got a great extreme; every thing has got a great extreme; that which Cheu-tsz' called the great extreme is the exemplified virtue of everything that is extremely good and extremely perfect in heaven and earth, men and things."

We would say, "it is every one's ideal," as Rückert expresses it:

"Vor jedem steht ein Bild des, das er werden soll,
Und vor er es nicht ist, ist nicht sein Friede voll."

[An image of what it ought to be lives in each creature's mind
So long as that is unattained, its peace it cannot find.]

We can scarcely appreciate the difficulties which Cheu-tsz' and Chu Hi had to overcome in the dualistic terminology of their national tradition. The term T'ai Kih (Great Extreme) dates back to earlier days, but the monistic conception derived from its application was new; and it was a triumph of philosophical thought which their inventors, considering the circumstances of the situation, had good reasons to prize highly. Chu Hi says:

"The great extreme is the immaterial principle of the two powers, the four forms, and the eight changes of nature; we cannot say that it does not exist, and yet there is no form or corporeity that can be ascribed to it. From this point is produced the one male and the one female principle of nature, which are called the two powers; also the four forms and the eight changes proceed from this, all according to a certain natural order, irrespective of human strength in its arrangement. But from the time of Confucius no one has been able to get hold of this idea. Until the time of Sháu Kangtsie, when this doctrine was explained, and it appeared very reasonable and pleasing. It may not therefore be treated with lightness, and should be more particularly inquired into."

In a word, the monistic school of Cheu-tsz' and Chu Hi are in the history of Chinese thought what Kant is in the Western world. They discovered that the Yang and Yin manipulations are what we would call the most abstract algebra of thought or the science of pure forms, embodying the universal and necessary laws of both the objective realm of existence and the subjective realm of man's mentality.

FILIAL PIETY 孝

European and American civilisation has less firm foundations in us as compared with the deep root which the Chinese view of life has struck in the souls of Chinamen. It is reflected in their institutions, in their arts, in the habits of their daily life,[1] in their symbolism, in their language, and above all in their ethics which reflects their views of the relation of Yang to Yin, being in its noblest conception the completest submission of a child to the will of his father, a virtue which is called in Chinese 孝 *Hiao*.[2]

As an instance of the influence of the Yang and Yin philosophy upon the life of all nations that have ever felt the influence of the Chinese world-view, we state that the name of the greatest Japanese monthly is "The Great Yang"; which is translated by the editors by "The Sun." The flag of the Coreans shows the diagram of the symbol of the primordial source of existence (as it appears in Fig. 13) in blue and red colors, surrounded by the trigrams Ch'ien, Kân, Lî, and Kw'un, "☰ ☵ ☶ ☷."

As an example of the artistic representation of Yang and Yin, we here reproduce a Japanese picture (facing p. 224), which represents a double door of the main entrance in a public building.

The most important field in which the Yang and Yin philosophy exercises its influence is in the domain of ethics. The dualism that still lingers in Chinese thought finds its expression in the Chinese code of morals which always implies an external relation between two, an authoritative master and an obedient servant, the duty of the former being wisdom in government, and of the latter submission. One of the favorite treatises of Chinese literature, the booklet entitled *The Classic of Filial Piety*,[3] sets forth the idea that "filial

[1] As a thoroughly reliable description of Chinese life we recommend Prof. Robert K. Douglas's works, *Chinese Stories*, W. Blackwood & Sons, Edinburgh, 1893, and *Society in China*, A. D. Innes & Co., London, 1894.

[2] The character *Hiao*, 孝, filial piety, shows a child supporting an old man.

[3] *Sacred Books of the East*, Vol. III., pp. 447–448. The book was written either by Tsang-tsz', the disciple of Confucius, or by one of Tsang-tsz' 's school.

devotion is the root of virtue." Filial devotion is said to be "the maxim of Heaven, the righteousness of Earth, and the duty of man"

The idea of filial piety is widened into devotion as it applies to the five moral relations that obtain between man and man; viz., between (1) sovereign and subject, (2) parent and child, (3) elder brother and younger, (4) husband and wife, (5) friend and friend.[1]

When asked by Tsang whether in the virtue of the sages there was not something higher, Confucius replied:

"Of all (creatures with their different) natures produced by Heaven and Earth, man is the noblest. Of all the actions of man there is none greater than filial piety. In filial piety there is nothing greater than the reverential awe of one's father. In the reverential awe shown to one's father there is nothing greater than the making him the correlate of Heaven."

The higher monistic ethics, which becomes possible only on an advanced plane in the evolution of mankind, unites both the governor and the governed in one person and expects every one to be his own king, priest, and instructor, replacing the external relation by an internal relation. This principle of a monistic ethics was first proclaimed in the history of European civilisation by the reformers of the sixteenth century, who taught self-dependence and claimed the liberty of conscience. Liberty of conscience, self-reliance, the right of free inquiry and free thought abolish personal authority, not for the sake of anarchy, but to replace it by the superpersonal authority of justice, right, and truth.

Filial devotion remains submission, as we read in Chapter XI:

"When constraint is put upon a ruler, that is the disowning of his superiority; when the authority of the sages is disallowed, that is the disowning of (all) law; when filial piety is put aside, that is the disowning of the principle of affection. These (three things) pave the way to anarchy."

Rebels are punished with brutal severity, yet there are frequent revolutions in China; and the Shu King goes so far even as to sanction them, provided they be successful. We read:

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[1] The fivefold relationship which constitutes the substance of Chinese ethics is supplemented by K'ung Ki's principle that good is the middle way between two extremes—a doctrine, which by Western critics has been censured as "the ethics of mediocrity." K'ung Ki was a grandson of Confucius.

"Heaven establishes sovereigns merely for the sake of the people; whom the people desire for sovereign, him will Heaven protect; whom the people dislike as sovereign, him will Heaven reject.

"[The Sovereign's] real way of serving Heaven is to love the people.

"When he fails to love the people Heaven will, for the sake of the people, cast him out."

Thus revolutions are regarded as ordeals in which success or failure signify the decision of heaven.

How the spirit of devotion is carried to the extreme, can be illustrated by many instances of Chinese habits, history, and stories. We quote one tale, which is at once typical and terse, from a popular book called *The Twenty-four Filials*:[1]

"In the days of the Han dynasty lived Koh Kü, who was very poor. He had one child three years old; and such was his poverty that his mother usually divided her portion of food with this little one. Koh says to his wife, 'We are so poor that our mother cannot be supported, for the child divides with her the portion of food that belongs to her. Why not bury this child? Another child may be born to us but a mother once gone will never return.' His wife did not venture to object to the proposal; and Koh immediately dug a hole of about three cubits deep, when suddenly he lighted upon a pot of gold, and on the metal read the following inscription: 'Heaven bestows this treasure upon Koh Fü, the dutiful son; the magistrate may not seize it, nor shall the neighbors take it from him.'"[2]

The neglect of what Western nations would consider as the highest duties is frequently enjoined for the sake of parents; and in agreement with this code of morals, the Chinese Emperor of late concluded to yield to all the demands of the victorious Japanese only that the Empress dowager in Pekin should not be obliged to be inconvenienced by a removal of the Imperial Court.

While on this important point our Western ideas of morality are different from those of the Chinese, we ought to consider that our American youths go to the other extreme. They can still learn from the Chinese, whose devotion to old parents is sometimes truly elevating and touching; and we have to add that one of the chief obstacles, although not the only one, to the introduction of Christianity into China are such words of Christ's as these:

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[1] 二十四孝

[2] Quoted from Williams's *Middle Kingdom*, Vol. I., p. 539.

"If any man come to me, and hate not his father, and mother, and wife, and children, and brethren, and sisters, yea, and his own life also, he cannot be my disciple."—Luke, xiv, 26.

"I am come to set a man at variance against his father, and the daughter against her mother, and the daughter-in-law against her mother-in-law."—Matth., x, 35.

The dualism of Chinese ethics finds expression in a rigid code of ceremonial forms. Who ever met an educated Chinese gentleman and was not struck by his extraordinary and almost painfully polite demeanor? How much stress is laid upon details in propriety, we can gather from the following injunction of courtesy toward visitors as quoted by Williams, in his *Middle Kingdom*, Vol. I., p. 540, from Chu Hi's "Juvenile Instructor" (*Siao Hioh*):

"Whoever enters with his guests, yields precedence to them at every door; when they reach the innermost one, he begs leave to go in and arrange the seats, and then returns to receive the guests; and after they have repeatedly declined he bows to them and enters. He passes through the right door, they through the left. He ascends the eastern, they the western steps.

"If a guest be of a lower grade, he must approach the steps of the host, while the latter must repeatedly decline this attention; then the guest may return to the western steps, he ascending, both host and guest must mutually yield precedence: then the host must ascend first, and the guests follow. From step to step they must bring their feet together, gradually ascending—those on the east moving the right foot first, those on the west the left."

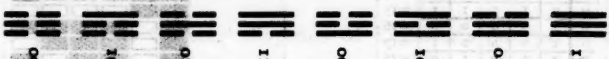
THE SIGNIFICANCE OF THE 易 YIH.

We ask now, what is the original significance of the Yih King, and, without attempting to decide the problem, present some solutions which have been proposed by various scholars.

The oldest European interpretation of the Kwa comes from the pen of no less an authority than the great Leibnitz. On explaining, in the *Mémoires de l'Académie Royale des sciences* (1703, III., p. 85), the nature and advantage of the binary or dyadic system of numeration, which employs only the symbols 0 and 1, expressing 2 by 10, 3 by 11, 4 by 100, 5 by 101, 6 by 110, 7 by 111, etc., he makes reference to the Kwa of the Yih King, which he calls "cova."[1] He says:

[1] "Cova" is the same as "coua," "v" being equal to "u."

"Ce qu'il y a de surprenant dans ce calcul, c'est que cette arithmétique par o et 1 se trouve contenir le mystère des lignes d'un ancient roi et philosophe nommé Fohy, qu'on croit avoir vécu il y a plus de quatre mille ans, et que les Chinois regardent comme le fondateur de leur empire et de leurs sciences. Il y a plusieurs figures linéaires qu'on lui attribue. Elles reviennent toutes à cette arithmétique, mais il suffit de mettre ici la figure de huit Cova comme on l'appelle, qui passe pour fondamentale, et d'y joindre l'explication, qui est manifeste, pourvu qu'on remarque premièrement qu'une ligne entière ▬ signifie l'unité ou 1, et secondement qu'une ligne brisée ▬ ▬ signifie le zéro ou o.



000	001	010	011	100	101	110	111
0	1	10	11	100	101	110	111
0	1	2	3	4	5	6	7

"Les Chinois ont perdu la signification des Cova ou linéations de Fohy, peut être depuis plus d'un millénaire d'années; et ils ont fait des commentaires là-dessus, où ils ont cherché je ne sais quels sens éloignés. De sorte qu'il a fallu que la vraie explication leur vînt maintenant des Européens. Voici comment. Il n'y a guère plus de deux ans que j'envoyai au R. P. Bouvet, Jésuite français célèbre, qui demeure à Pekin, ma manière de compter par o et 1, et il n'en fallut pas d'avantage pour le faire reconnaître que c'est la clef de figures de Fohy. Ainsi m'écrivant le 14. Novembre, il m'a envoyé la grande figure de ce prince philosophe qui va à 64, et ne laisse plus lieu de douter de la vérité de notre interprétation, de sorte qu'on peut dire que ce Père a déchiffré l'énigme de Fohy à l'aide de ce que je lui avais communiqué. Et comme ces figures sont peut-être le plus ancient monument de science qui soit au monde, cette restitution de leur sens, après un si grand intervalle de temps, paraîtra d'autant de plus curieuse.

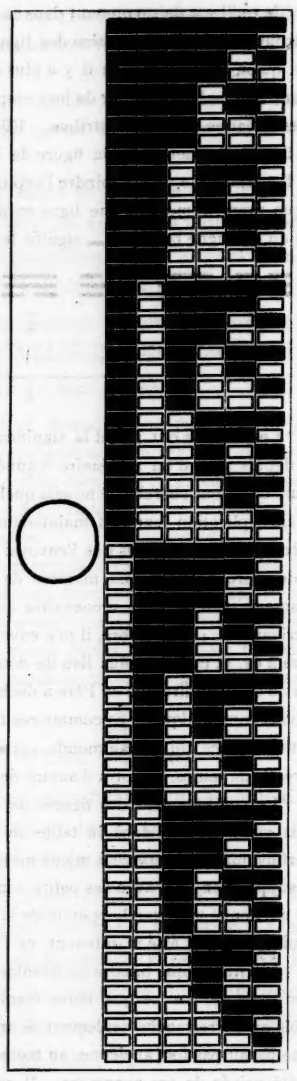
"Le consentement des figures de Fohy et de ma Table des Nombres se fait mieux voire lorsque dans la table on supplée les zéros initiaux, qui paraissent superflus, mais qui servent à mieux marquer la période de la colonne, comme je les y ai supplées en effet avec des petits ronds pour les distinguer des zéros, et cet accord me donne une grande opinion de la profondeur des méditations de Fohy. Car ce qui nous paraît aisé maintenant, ne l'était pas dans ce temps éloigné.

"L'arithmétique binaire ou dyadique est en effet fort aisé aujourd'hui pour peu qu'on y pense, par ce que notre manière de compter y aide beaucoup, dont il semble qu'on retranche seulement le trop. Mais cette arithmétique ordinaire par dix ne paraît pas fort ancienne, au moins les Grecs et les Romains l'ont ignorée, et ont été privés de ses avantages. Il semble que l'Europe en doit l'introduction à Gerbert, depuis Pape sous le nom de Sylvestre II, qui l'a eu des Maures d'Espagne.

"Or comme l'on croit à la Chine que Fohy est encore auteur des caractères Chinois ordinaires, quoique fort altérés par la suite des temps: son essay d'arithmé-

0	0	0	0	0	0	= 0
0	0	0	0	0	1	= 1
0	0	0	0	1	0	= 2
0	0	0	0	1	1	= 3
0	0	0	1	0	0	= 4
0	0	0	1	0	1	= 5
0	0	0	1	1	0	= 6
0	0	0	1	1	1	= 7
0	0	1	0	0	0	= 8
0	0	1	0	0	1	= 9
0	0	1	0	1	0	=10
0	0	1	0	1	1	=11
0	0	1	1	0	0	=12
0	0	1	1	0	1	=13
0	0	1	1	1	0	=14
0	0	1	1	1	1	=15
0	1	0	0	0	0	=16
0	1	0	0	0	1	=17
0	1	0	0	1	0	=18
0	1	0	0	1	1	=19
0	1	0	1	0	0	=20
0	1	0	1	0	1	=21
0	1	0	1	1	0	=22
0	1	0	1	1	1	=23
0	1	1	0	0	0	=24
0	1	1	0	0	1	=25
0	1	1	0	1	0	=26
0	1	1	0	1	1	=27
0	1	1	1	0	0	=28
0	1	1	1	0	1	=29
0	1	1	1	1	0	=30
0	1	1	1	1	1	=31
1	0	0	0	0	0	=32
1	0	0	0	0	1	=33
1	0	0	0	1	0	=34
1	0	0	0	1	1	=35
1	0	0	1	0	0	=36
1	0	0	1	0	1	=37
1	0	0	1	1	0	=38
1	0	0	1	1	1	=39
1	0	1	0	0	0	=40
1	0	1	0	0	1	=41
1	0	1	0	1	0	=42
1	0	1	0	1	1	=43
1	0	1	1	0	0	=44
1	0	1	1	0	1	=45
1	0	1	1	1	0	=46
1	0	1	1	1	1	=47
1	1	0	0	0	0	=48
1	1	0	0	0	1	=49
1	1	0	0	1	0	=50
1	1	0	0	1	1	=51
1	1	0	1	0	0	=52
1	1	0	1	0	1	=53
1	1	0	1	1	0	=54
1	1	0	1	1	1	=55
1	1	1	0	0	0	=56
1	1	1	0	0	1	=57
1	1	1	0	1	0	=58
1	1	1	0	1	1	=59
1	1	1	1	0	0	=60
1	1	1	1	0	1	=61
1	1	1	1	1	0	=62
1	1	1	1	1	1	=63

BINARY SYSTEM OF LEIBNITZ.



CHOW TSE'S DIAGRAM.

It will be of interest to compare Leibnitz's binary numbers with Chow-tsze's design; the similarity among which will appear as soon as 0 is identified with the black ■ and 1 with the white □ spaces.

tique fait juger qu'il pourrait s'y trouver quelque chose de considérable par rapport aux nombres et aux idées, si l'on pouvait déterrer le fondement de l'écriture Chinoise, d'autant plusqu'on croit à la Chine, qu'il a eu égard aux nombres en l'établissant. Le R. P. Bouvet est fort porté à pousser cette pointe, et très capable d'y réussir en bien de manières. Cependant je ne sais s'il y a jamais eu dans l'écriture Chinoise un avantage rapprochant de celui qui doit être dans une caractéristique que je projette. C'est que tout raisonnement qu'on peut tirer des notions, pourrait être tiré de leurs caractères par une manière de calcul, qui serait une des plus importans moyens d'aides de l'esprit humain."

Prof. Moritz Cantor,[1] disposes of Leibnitz's interpretation of the Kwa because "Mr. Duhalde had proved them to be projective drawings of the knotted cords." He adds that they must, according to Bouvet, be regarded, on account of their names, not as numbers, but as physical symbols, and explains Leibnitz's theory as exclusively due to his philosophical interpretation of the binary system, which was to him an evidence in favor of his conception of a creation from nothing or zero with the sole assistance of One or the unit. But Cantor seems to overlook that in this very respect the ancient Yang and Yin philosophy of the Chinese closely resembles Leibnitz's idea, whether we regard the Kwa as numbers, or as a binary system of such symbols as are still more general and indefinite. The fact of both their presence and their philosophical significance remains the same and cannot be doubted.

The first translation of the 易 Yih is in Latin. It was made by the Jesuit P. Regis with the assistance of some of his colleagues, and edited in two volumes by Julius Mohl.[2]

Prof. James Legge's translation is based upon the idea that the book in its main parts and originally was intended to be a kind of political testament of King Wen and the Duke of Cheu, enlarging on moral and social questions, but enigmatically written after the manner and fashion of diviners. He therefore tries to bring his mind *en rapport* with the mind of its authors and paraphrases the meaning of the disconnected words and sentences in the sense that he

[1] In his *Mathematische Beiträge zum Kulturleben der Völker*, Halle, 1863, p. 49.

[2] Y King, Antiquitissimus Sinarum liber, quem ex latina interpretatione P. Regis aliorumque ex Soc. Jesu P. T., edidit Julius Mohl. Stuttgartiæ et Tübingæ. 1834.

finds indicated in the text. He encloses his additions in parentheses, saying:

"I hope, however, that I have been able in this way to make the translation intelligible to readers. If, after all, they shall conclude that in what is said on the hexagrams there is often 'much ado about nothing,' it is not the translator who should be deemed accountable for that, but his original."

A peculiar conception of the Yih King has been propounded by P. L. F. Philastre, who lays much stress on the tradition that Fuh-Hi received his first idea of the Kwa by contemplating the starry heavens and believes that he discovered in the Kwa combinations a method of symbolising the astronomical lore of the ancient Chinese. His lucubration embodies translations of the most important Chinese commentaries.[1]

Canon McClatchie published a translation of the Yih King in which he ventures to open its mysteries "by applying the key of comparative mythology." I have not seen it and quote only what Professor Legge has to say about it (*Sacred Books of the East*, Vol. XVI, p. xvii):

"Such a key was not necessary and the author by the application of it, has found sundry things to which I have occasionally referred in my notes. They are not pleasant to look at or dwell upon, and happily it has never entered into the minds of Chinese scholars to conceive them."

A. Terrien de Lacouperie[2] believes that the Yih King is a mere vocabulary containing those word-symbols which the Bak families brought with them as a sacred inheritance of the Elamo-Babylonian civilisation.

P. Angelo Zottoli says of the Yih King in his *Cursus Literaturae Sinicae*:

"A. Terrien de Lacouperie believes that the old Chinese civilisation is an offshoot of the Elamo-Babylonian civilisation in the very stage of development that had been reached a little after the middle of the third millennium B. C., and claims that the hexagrams are the script which the Bak tribes, the oldest civilisers of China, carried with them to the new homes, and the Yih King is originally a dictionary of the ancient word-symbols with their lexicographical explanations, the mean-

[1] *Annales du Musée Guimet*, Vols. VIII. and XXIII.

[2] *The Oldest Book of the Chinese, the Yi King and Its Authors.* London: D. Nutt, 270 Strand, 1892.

ing of which was later on misunderstood without losing the awe that naturally was attached to the book as embodying the wisdom of the sages of yore."

"The book consists of the figures of Fuh Hi, of the divinations of King Wen, of the symbols of the Duke of Cheu, and the commentaries of Confucius. From the permutations which the two elements in the composition of the hexagrams undergo it is called Yih (the permutator), or Yih King, the Book of Permutations. What, then, is this famous Yih King? It is, briefly, this. From the continuous or bisected quality of the lines, their position either at the bottom or in the middle or topmost, their mutual relation as being opposed and separated, or coming together, the body or form of the trigrams themselves; further, from the symbol or image of the trigrams, from the quality or virtue of the trigrams, sometimes from the difference of one hexagram as compared to another, a certain picture is developed and a certain idea is deduced containing something like an oracle that can be consulted by drawing lots, in order to obtain some warning fit for guidance in life or to solve some doubt. Such is the book according to the explanations of Confucius as handed down in the schools. Therefore, you must expect neither anything sublime or mysterious, nor anything unseemly or vile. I see in it rather a subtle play for eliciting moral and political instructions, such as can be found in the Chinese classics, obtrusive, plain, and natural. Since this book, as a reader of the original text will understand, has been employed for fortune telling, one expects to gain by it the highest happiness of life, mysterious communication with spirits and occult knowledge of future events. Therefore, the book appears as a magic revelation, as a perfect light, as throughout spiritual and conformable to the life of man. Hence the praises attributed to it by Confucius, although quite exaggerated, will be seen specially added in the Appendix of the book, if it is true at all as the common opinion goes, that he himself is the author of the Appendix."[1]

Ch. de Harlez, the originator of the idea that the nature of the Yih King is lexicological, does not accept Lacouperie's theory of an Elamo-Babylonian origin of the Yih King. He says in the preface to his French translation of the Yih[2]:

"Notre système . . . nous fait voir dans le Yih un reccueil mi-lexicologique, mi-philosophique de termes et de sentences, plein de raison et de sagesse."—P. 11.

There remains one more hypothesis on the nature of the Yih King which is by Dr. Heinrich Riedel, of Brooklyn, N. Y. He has given me much assistance in my own Chinese studies and I am inclined to believe that he has something to say on the subject that is

[1] Translated from the Latin. The original is quoted by Legge in his Preface to the *Yih King*, p. xviii.

[2] Published in 1889 by F. Hayer, Bruxelles, rue de Louvain, 108.

worth hearing. Since his observations have never been published, I deem it advisable, for the sake of sinology, to present some chips from his workshop.

Dr. Riedel regards the Yih as a calendar of the lunar year, being what the title of Cheu-tsz' 's book on the Yih indicated, a *T'ung Shu*, "a universal book," or "almanac," embodying everything in the domain of science, religion, ethics, and even sport that appeared of interest. *T'ung Shu* means "calendar," and $6 \times 64 = 384$ (the number of strokes in the hexagrams) is the number of days of the intercalary year. As to the hexagrams, Dr. Riedel insists that "the specific order of the sixty-four hexagrams which is carefully preserved and sacredly guarded by devices that remind us of the Massoretic precautions taken in regard to the Hebrew texts of the Bible and which has yet received little if any attention, is the soul and substance of the Yih King," and trusts to be able to prove that the circular device of hexagrams including the square represents "the problem of squaring the circle." Here are, in a condensed form, some points of his theory:

There is in Chinese authors a frequent substitution of symbols by homonyms; as Gabelentz says: "The ancient authors either through mistake or in emergency, or by sheer whim, used to replace the character of a word by another one which probably in their age had the same or a very similar sound." (*Gr. Ch. Gr.* p. 100.) And this must be expected to have taken place in the Yih King rather more freely than in other books. Now take the first sentence of the Yih King and replace it by homonyms as follows:

乾元亨利貞

見圓行理正

Both lines read nearly alike: "K'ien yuen hăng li ching;" but the former means "K'ien, origin (and) progress determined by advantageousness," while the latter means "See the circle's path rectified by reason."

The aphorism belonging to the first (viz. the lowest) Yang line of the first Kwa, which reads "Ts'ien lung wuh, yung," Dr. Riedel

translates: "A hidden dragon through negation is action," which is meant to set forth the mathematical and logical powers of naught (o).

Legge is unable to bring sense into a passage in which robbery is declared to teach ethics (*Sacred Books of the East*, III., p. 203, § 48). The paragraph, however, becomes clear when we adopt Dr. Riedel's proposition to regard robbery as a game like chess and translate it by "latrunculi" or robbery-game. Burden-bearers, i.e. peasants or laborers, should be translated by "pawns." Other allusions that occur in the passage, such as "false moves," "leaving exposed," "attacking," "captured," remind us of our own chess-board terms. In addition, we meet in the Yih *passim* with generals, the tsz', i. e., sages or advisers, horses, carriages, and elephants.[1]

Legge translates the aphorism of the second Yang line of the second kwa thus:

"(The second line divided) [shows the attribute of] being straight, square, and great. (Its operation) without repeated efforts will be in every respect advantageous."

Dr. Riedel proposes a more literal translation:

"Rectify square greatly (viz. ever so much), not continuously employing naught, no gain."

The Yang and Yin lines are designated by *kiu* 九 and *luh* 六 two characters which ordinarily mean nine and six. Dr. Riedel claims with great plausibility, that they are employed to designate diameter and radius. *Kiu* means not only "nine," but also "to go to the end of; to go through; or, to bring together." It is a homonym with 糾, its inversion,[2] which means "to take hold of; to join; to connect." Further, *luh* means "six," and in analogy with 二 *'rh*, which means "two" and "to divide into two," *luh* means also "to divide into sixes" and then sextant, the sixth part of a circle or the radius which is equal to the chord of a sextant. This makes it probable that *kiu* in the Yih King means diameter-line; and *luh* radius line, which again are identified with the full line of Yang and the broken line of Yin.

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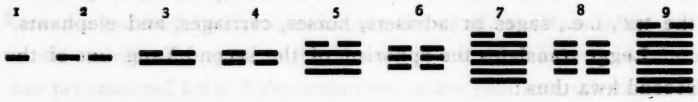
[1] On the chess of the Chinese see Williams's *Middle Kingdom*, I., p. 827.

[2] 糾 *chiu*, "to take hold of," represents a creeping plant twining over a wall.

A passage quoted from K'ung Ngan Tsz' Quoh reads:

"The spirit tortoise carried a writing and methodically arranged divisions. In both respects it had *the digits up to nine.*"

Comparing this with a passage in the Book of Three Characters[1] which declares that the five elements "have their origin in numbers," Dr. Riedel deduces from observations made on the carapace of a half-grown Chrysemys picta,[2] which on account of its abnormal number of inner and outer plates a Chinaman would class as a shan kwei, or spirit tortoise, the following writing of the nine digits as a hypothetical reconstruction of the Loh Shu in its substance:



The sum of the Kiu lines is 16, of the Luh lines 29.

The plates on the back of the tortoise yield the same numbers in the same proportion. There are sixteen large inner plates, while there are twenty-three small outer plates, and in addition we have three pairs of small ones that appear to be superimposed upon the three vertebral plates in the centre. The symbols of the five elements, as written on p. 208, yield sixteen long and twenty-nine short lines.

Now, by means of the same distribution of whole and broken lines amongst the nine digits, Dr. Riedel claims to have constructed "an anagram of the number π in one hundred and twenty-three decimal places, exhibiting the sixty-four Yih kwa in their specific order, placed in rows of eight each, from below upwards." The use of an anagram for the purpose of laying down a scientific truth at the time inaccessible, is by no means a device unheard of in the history of science; for in comparatively recent times such men as Roger Bacon, Galileo, and Huygens have done the same thing.

The spiritual tortoise accordingly is a *lusus naturae* which ap-

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[1] 三字經 An English translation of this booklet is published in *The Open Court*, No. 412. The passage quoted above is characters 199–204.

[2] See Fig. 10 on p. 207.

pealed to the mathematical mind of the Chinese and caused them to see in it a spiritual being.

If Dr. Riedel's theory is not the restoration of the ancient Chinese conception, we may rest assured that it was some quite analogous scheme.

Dr. Riedel, in further attempts at proving the presence of the number π in the order of the Kwa of the Yih King, quotes from *Hi tsz'* (App. iii, 1, § 70) the sentence: "The Yih contains the great extreme," and says, "Now as the great extreme which is symbolised by a circle is not mentioned at all, and as we have in the Yih King proper only the mutations of Yang and Yin, the Luh and Kiu, the two symbols (Liang Î), I conclude that they, if anything, must contain the number by which to calculate the circle" (i. e., the symbol of the great extreme). In addition to this argument, Dr. Riedel quotes the passage *Yih Nih Shu Ye*, i. e., "the mutations (are) a refractory number," "refractory number" being defined in *Shwoh Kwa* (App. V. 2) by "making acquainted with the future," which is the opposite to a number that has reference to the past, and is consummated or "compliant." "Accordingly," says Dr. Riedel, "a refractory number can, in the adduced passage, mean only what we call an irrational number."

In the beginning of the same Appendix we read: "The holy men of yore who composed the Yih, concealed their help in spiritual light and thus gave life to the milfoil stalks. They triangulated[1] the heaven, made twofold the earth, and relied upon calculation." All commentators and interpreters agree that in this sentence heaven means the circle, and earth the square. Dr. Riedel suggests that "making twofold the earth (viz., the square) indicates the primitive method of approximating π by circumscribed and inscribed squares."

The aphorism of the fourth hexagram declares:

"Inexperienced one, proceed. We do not seek the youthful and inexperienced. The youthful and inexperienced shall seek us. In its first (elements) divination is propounded. Further details (literally, the second and third) would be tedious. Tedious rules are not propounded."

[1] The ancient character for the verb "to triangulate" contains three triangles. Compare the English word "trigonometry."

As to the original meaning of "divination" in the minds of the Chinese, Dr. Riedel adduces from an English-Chinese dictionary the explanatory character *swan*, which denotes "the Chinese abacus," "to cipher," "a calculation," which goes far to prove that the fundamental meaning of "divination" is closely connected with mathematical, arithmetical, and logical determination.

In addition to all this it is, at least, a strange coincidence that the name of the dynasty *Cheu*, 周 after which the present book of Yih is called, means "periphery, curve, enclosure." The verb *cheu* is translated by Williams, "to make a circuit; to environ."

It cannot be my purpose to enter further into Dr. Riedel's arguments, not only because an elaborate proof must, in the very nature of things, be very complicated, but also because I am not sufficiently acquainted with all the details of his further evidence. Dr. Riedel's proposition is, to say the least, not less probable than any one of the other theories of the Yih King that have been advanced. I have devoted more space to it because it is as yet unknown, and, being very striking and ingenious, it is worthy of a careful consideration. Many of his observations which I have inquired into as carefully as I could, with my still limited knowledge of the Chinese language, appear to me correct: but I have not as yet been persuaded to adopt his main theories, that the Yih is a calendar and that a portion of it is devoted to the problem of squaring the circle.

TIEN 天 AND SHANG TI 上帝 THE BELIEF IN A PERSONAL GOD.

At first sight there does not seem to be much room in the Yang and Yin philosophy for a personal God. Nevertheless, the Chinese believe in 上帝 the Lord on High, who is the sole ruler of the universe and the sole God above all the mythological deities.

The divine power to which men look up as to their authority of conduct is commonly designated with the impersonal term 天 T'ien,[1] i. e., Heaven, which may be translated by Godhood or Deity.

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[1] 天 *T'ien* consists of 大 "great" and 一 "one."

If conceived as a personal being T'ien is called Shang Ti, i. e. the High Sovereign, or the Lord on High.

The worship of Shang Ti must be very old, for we read that after a severe drought Ching Tang, the founder of the Shang dynasty, which began 1766 B. C., publicly paid religious worship to Shang Ti, confessing his offences, which were six. He had scarcely finished his confession when the rain fell in torrents. We must add that on this occasion the worship of Shang Ti is not related as an innovation, but as a means of deliverance that naturally suggested itself to a good ruler.[1]

In the very oldest documents of the Shu King the term "Heaven" is used as is our deity, implying even the conception of a personal being. Thus we read in the Counsels of Kâo-Yâo:

"The work [i. e., the bringing to an end] is Heaven's; but men must act for it.[2]

"From Heaven are the relationships with their several duties. From Heaven are the [social] distinctions with their several ceremonies.

"Heaven punishes the guilty.

"Heaven hears and sees as our people hear and see. Heaven brightly approves and displays its terrors as our people brightly approve and overawe. Such connexion is between the upper and lower (worlds)."—*Sacred Books of the East*, III., pp. 55–56.

Quotations like these can be multiplied by the thousands. We have purposely limited them to the most ancient documents in the Shu King in order to prove that the idea of a supreme personal deity is not of modern date. At present the worship of Shang Ti is regarded as so holy that the emperor, as the High Priest of the nation, is alone permitted to perform the ceremony.

Peking, the capital of China consists of three cities: the Tartar city to the North, the Forbidden city with the imperial palaces and parks lying within the Tartar city, and the Chinese city to the South. In the southern part of the Chinese city is a park of about a square mile containing the Temple of Heaven and the Altar[3] of Heaven,

[1] See Williams's *The Middle Kingdom*, II., p. 154.

[2] Or better: "Consummation is Heaven's, but men must work for it."

[3] We retain this traditional translation "altar," although it is misleading since it suggests the erroneous idea that it must be an altar such as we see in Catholic churches or as it was used by the ancient Greeks.

which are to the Chinese the most sacred spots on earth. The Temple of Heaven (or more correctly, "the Altar of praying for grain") is a triple marble terrace, twenty-seven feet in height, surrounded with marble balustrades and crowned with a temple which rises to the height of ninety-nine feet. The three terraces and the temple are circular. The symmetry of the proportions renders it most beautiful; its dome imitates in shape and color the vault of heaven, and as the round windows are shaded by blinds of blue glass-rods strung together, the entering sun casts an azure light upon the rich carvings and paintings in the inside. The same park in which the Temple of Heaven stands, contains the Altar of Heaven, which is enclosed by an outer square wall and an inner circular wall; and it is here that the emperors of China at the time of our Christmas have been in the habit, from time immemorial, of worshipping 上帝 Shang Ti, "the Lord on High," or as the Emperor Kanghi expressed himself: "the true God." The Altar of Heaven (a picture of which forms the frontispiece to the first volume of Williams's *Middle Kingdom*) is described by Williams as follows[1]:

"It is a beautiful triple circular terrace of white marble, whose base is 210, middle stage 150, and top 90 feet in width, each terrace encompassed by a richly carved balustrade. A curious symbolism of the number three and its multiples may be noticed in the measurements of this pile. The uppermost terrace, whose height above the ground is about eighteen feet, is paved with marble slabs, forming nine concentric circles—the inner of nine stones inclosing a central piece, and around this each receding layer consisting of a successive multiple of nine until the square of nine (a favorite number of Chinese philosophy) is reached in the outermost row. It is upon the single round stone in the centre of the upper plateau that the Emperor kneels when worshipping Heaven and his ancestors at the winter solstice."

This round stone, we must remember, is the symbol of the T'ai Kih, ○, the ultimate ground of being. Williams continues:

"Four flights of nine steps each lead from this elevation to the next lower stage, where are placed tablets to the spirits of the sun, the moon, the stars, and the Year God. On the ground at the end of the four stairways stand vessels of bronze in which are placed the bundles of cloth and sundry animals constituting a part of the sacrificial offerings. But of vastly greater importance than these in the matter of

[1] See Williams's *Middle Kingdom*, I., 76–77, and *The Dragon, Image, and Demon*, by Du Bose, New York, 1887 (pp. 57–64).

burnt-offering is the great furnace, nine feet high, faced with green porcelain, and ascended on three of its sides by porcelain staircases. In this receptacle, erected some hundred feet to the southeast of the altar, is consumed a burnt-offering of a bullock—entire and without blemish—at the yearly ceremony. The slaughter-house of the sacrificial bullock stands east of the North Altar, at the end of an elaborate winding passage, or cloister of seventy-two compartments, each ten feet in length."

Such is the religious and popular conception of Shang Tî, which is as deeply rooted in the Chinese mind, and perhaps more deeply than is the God-idea in the West. But just as Western philosophers translate the God-idea of religion into a philosophical principle, (I mention Hegel's Absolute, Schopenhauer's Will, Fichte's Moral World-Order, Spinoza's definition of Substance, etc.,) so the educated Chinese speak of Lao-tsz''s Tao or World-Logos, of Cheu Tsz''s T'ai Kih or the ultimate ground of existence, and of Chu Hi's Li or immaterial principle. Chu Hi touches upon the problem of the personality of God in his expositions on the immaterial principle and primary matter. He says after quoting three passages from the classics in which the terms Shang Ti and T'ien (the Lord on High and Heaven) imply the idea of a personal God:

"All these and such like expressions, do they imply that above the azure sky there is a Lord and Ruler who acts thus, or is it still true that heaven has no mind, and men only carry out their reasonings in this style? I reply, these three things are but [expressions of] one idea; it is that the immaterial principle of [the cosmic] order is such."

This seems to imply that his conception of the k'i implies personality; but he adds:

"The primary matter, in its evolutions hitherto, after one season of fulness has experienced one of decay, and after a period of decline, it again flourishes; just as if things were going on in a circle. There never was a decay without a revival."—*Chinese Repository*, Vol. XIII., p. 555.

There is an extensive literature on the question; for some Christian missionaries have objected to the translation of Shang Ti by God and God by Shang Ti, proposing other words in its place.[1]

[1] See *The Chinese Repository*, Vol. XVII., pp. 17–53, 57–89 ("Essay on the Term for Deity," by William J. Boone, Bishop of the Protestant Episcopal Church); *ib.* pp. 105–133, 161–187, 209–242, 265–310, 321–354 ("Chinese Term for Deity,"

The controversy began with the Roman Catholic missions. The Jesuit Ricci, an unusual missionary genius, who rendered the Chinese government so many valuable services that he commanded the Emperor's highest respect and unbounded confidence, had drawn up rules for his Christian converts in which he permitted certain Chinese rites, such as honoring the memory of Confucius and of ancestors, justifying these acts by an explanation of their purely secular significance. Ricci at the same time translated, as a matter of course, the word "God" with Shang Tî, and his methods were silently approved in Rome.

Morales, a Spanish Dominican, however, jealous of the great success of his Jesuit brethren, denounced Ricci for pandering to idolatry. The propaganda condemned Ricci's methods as sinful, and Pope Innocence confirmed the sentence in 1645. The Jesuits remonstrated and succeeded. Pope Alexander VI. issued another decree, in which, without directly revoking his predecessor's decision, he sided with Ricci's policy,[1] in agreement with which, in 1665, the Jesuits drew up forty-two articles. The Dominicans did not let things rest here; Navarette, one of their order, renewed the old denunciations, and Bishop Maigrot, an apostolic vicar living in China, issued a mandate in which he declared that "T'ien" signified nothing more than "the material heaven," and that the Chinese customs and rites were idolatrous. The Jesuits applied to the Emperor of China for an authentic explanation of the significance of the words for God and of the Chinese rites, whereupon Kanghi the Emperor declared (in 1700) that T'ien meant the true God, and the ceremonies of China were political.

But the efforts of the Jesuits to influence the Pope failed; Pope Clement XI. confirmed the mandate of Bishop Maigrot in a bull (published in 1703) in which the words T'ien and Shang Tî were

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by Dr. W. H. Medhurst); *ib.* pp. 357–360 ("A Few Plain Questions by a Brother Missionary"); and *ib.* pp. 489 et seq., 545 et seq., and 601 et seq. ("Dr. Medhurst's Reply to Bishop Boone").

[1] Ricci's "Divine Law" is published in an unabridged form in Kircher's *China Illustrata*, 1667.

rejected as pagan, while the expression T'ien Chu, i. e. Lord of Heaven, was approved of.

From these days the rapid decline of the Roman Catholic missions in China begins. Ricci's doctrines were not countenanced in Rome, and Maigrot's followers were persecuted by the Chinese government.

Among Protestant missionaries the Rev. Dr. Boone proposes to translate God by Shin = Spirit,[1] and takes the field against all those who use the terms Shang Tî or T'ien; but he is opposed by the majority of his colleagues, Dr. Medhurst, Sir George Staunton, Dr. Bowring, Mr. Dotty, and Professor Legge.

Prof. James Legge has written a learned discussion on the subject[2]; adducing innumerable passages in corroboration of his views. In his introduction to the Shu King he quotes Tâi T'ung's dictionary in defining the meaning of the word "Tî." Tâi T'ung says:

"Tî is the honorable designation of lordship and rule, therefore Heaven is called Shang Tî; the Elementary Powers are called the five Tî; and the Son of Heaven—that is, the Sovereign—is called Tî."

Professor Legge adds:

"Here then is the name Heaven, by which the idea of Supreme Power in the absolute is vaguely expressed; and when the Chinese would speak of it by a personal name, they use the terms Tî and Shang Tî;—saying, I believe, what our early fathers did, when they began to use the word God.

"Tî is the name which has been employed in China for this concept for fully five thousand years. Our word God fits naturally into every passage where the character occurs in the old Chinese Classics. It never became with the people a proper name like the Zeus of the Greeks. I can no more translate Tî or Shang Tî by any other word but God than I can translate *zan* 人 by anything else but man."

The general belief that the Chinese are obstinately opposed to Christianity and Christian ethics is a great error. The Chinese have a contempt only for the dogmatism that is commonly preached to them as Christianity. In spite of all the missionary efforts of Christians, the Chinese know of Christianity as little as, or even less than, Western nations know of Confucius, Lao-tsz', and Buddha. How

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[1] 神

[2] *The Notions of the Chinese Concerning God and Spirits*, Hong Kong, 1852.

deeply the simple story of Jesus and his preachings of love and charity can impress the Chinese mind, if it is told in a truly Chinese way, without identifying Christianity with beef-eating or the opium trade, can be learned from the fact that the Tai Ping revolution, which shook the throne of the Celestial Empire, was conducted by native Christians who could no longer stand the persecutions of the Confucian authorities. Hung Sew Tseuen, a simple schoolmaster, who in his youth had seen visions entrusting him with a religious mission, read the Gospel, and, being impressed with its moral truths, baptised himself and began to preach Christ's ethics of good-will toward all. He was discharged and persecuted because he refused to pay the customary worship to Confucius; but he continued to preach until he saw himself at the head of an army that might have overpowered the government of the Chinese Empire. While this rebellion raged in China, the English did not even know that the rebels were Christians. So little did they know of the affairs of the interior of China!

Hung Sew Tseuen is described in *The Chinese and General Missionary Gleaner* as "of ordinary appearance, about five feet four or five inches high, well built, round faced, regular featured, rather handsome, about middle age, and gentlemanly in his manners."

Thomas Taylor Meadows, Chinese interpreter in H. M. Civil Service, has published a detailed account of the Tai Ping revolution[1] in his book, *The Chinese and Their Rebellions*, London, 1856. He says on page 193:

"My knowledge of the Chinese mind, joined to the dejected admissions that Protestant missionaries of many years' standing occasionally made of the fruitlessness of their labors, had convinced me that Christianity, as hardened into our sectarian creeds, could not possibly find converts among the Chinese, except here and there perhaps an isolated individual. Consequently when it was once or twice rumored that the large body of men who were setting Imperial armies at defiance 'were Christians,' I refused to give the rumor credence. It did not occur to me that the Chinese convert, through some tracts of a Chinese convert, might either fail to see, or (if he saw them), might spontaneously eliminate the dogmas and congealed forms of merely sectarian Christianity, and then by preaching simply the great religious truth of One God, and the pure morality of Christ's Sermon on the

[1] See also Rev. Th. Hamberg's article in the *N. Am. Review*, Vol. LXXIX., p. 158.

Mount, obtain numbers of followers among people disgusted with the idolatry and the immorality that they and those around them were engulfed in. As we have seen above, this was actually the case with Hung Sew Tseuen."

LAO-TSZ' 老子 AND CONFUCIUS 孔子

The Yang and Yin conception of the ancient Chinese has exercised a dominating influence upon all Chinese thinkers[1], with the sole exception of Lao-tsz', who lived at the end of the sixth century before Christ. Lao-tsz''s 道德經 *Tao-Teh-King* ("the Classic on Reason and Virtue," that wonderful booklet on 道 *Tao*, i. e., the Path or Method, the Word or Reason, the Logos, that was in the beginning and on 德 *Teh* virtue,[2] propounding an ethics that repudiates all self-assertion, closely resembling the injunctions of both Buddha and Christ), stands alone in the whole literature of China. It is not less monistic than the doctrines of the T'ai Kih, but less rigid, less *a priori*, less self-sufficient. It would have served the Chinese better than the Confucian philosophy.

Williams defines 道 *tao*, as follows:

"A road, path, or way; . . . a principle, a doctrine, that which the mind approves; used in the classics in the sense of the right path in which one ought to go either in ruling or observing rules; rectitude or right reason; in early times, up to 500 A. D., the Buddhists called themselves tao-yan, i. e., men (seeking for) reason [enlightenment], or intelligent men, denoting thereby their aspiration after 'pu-ti (Sanskrit *bodhi*), intelligence; the Reason or Logos of the rationalists" [the so-called Taoists].[3] . . . [As a verb *tao* means] "to lead, to direct, to go in a designated path; to speak, to converse."

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[1] On the literature of China, see Schott's "Entwurf einer Beschreibung der chinesischen Litteratur, gelesen in der Akademie der Wissenschaften," 1850, and published in the *Philosophisch-Historische Klasse* in 1853, pp. 293-418.

[2] 德 is a combination of the three radicals "to go," "straight," and "heart."

[3] The Taoists who regard themselves as followers of Lao-tsz' have distorted their master's doctrines beyond recognition. The Tao religion is best characterised in "The Book of Rewards and Punishments," translated in full only into French by Stanislaus Julien under the title *Le livre des récompenses et des peines*. Paris, 1835. See also *Confucianism and Taoism*, by Prof. Robert K. Douglas.

The character 道 *tao*, is composed of "to go" and "head," denoting "marching at the head."

We are told that Confucius visited Lao-Tsz', who, being by half a century his senior, must then have been about eighty years old. While Confucius propounded the maxims of justice, the old philosopher urged the principle of good-will toward every one, saying:[1]

"Recompense injury with kindness."

Confucius, unable to fathom Lao-tsz''s meaning, replied:

"With what then will you recompense kindness? Recompense injury with justice (punishment), and recompense kindness with kindness."

Lao-tsz' propounds the gist of his ethics in § 49 of the Tao-Teh-King, where he says:

"The good I would meet with goodness. The not-good I would also meet with goodness; for the *teh*[2] (virtue) is good (throughout). The faithful I would meet with faith. The not-faithful I would also meet with faith; (for) the *teh* (virtue) is good (throughout)."

Lao-tsz' objected to the very basis of Confucian morality. Confucius expected to make people good by teaching them propriety; if they were but respectful to parents and superiors, if they brought sacrifices to the shrines of their ancestors, and observed the appropriate rules and ceremonies, mankind would become moral. Lao-tsz' exhibited an undisguised contempt for externalities and ancestor-worship. He demanded purity of heart, emptiness of desire, and a surrender of all self-display, in imitation of the great Tao (Reason), which serves all without seeking its own.[3]

Sz' Ma Ts'ien,[4] who lived about 163–85 B. C., reports on the authority of Chwang-tsz' (about 330 B. C.) that Confucius in his interview with Lao-tsz', showed himself overawed by reverence for the wisdom of the ancient traditions. Lao-tsz' said:

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[1] John Chalmer's *The Speculations of the Old Philosopher, Lau-tsz'*, p. xviii.

[2] 德

[3] See also Douglas's *Confucianism and Taoism*, pp. 176 et seq.

[4] The original Chinese text with a German translation is published by Gabelentz in his *Anfangsgründe der Chinesischen Grammatik*, p. 111 et seq.

"Lord, of whom you speak, the men and their bones, I suppose, have altogether rotted away. Their words only are still extant. Moreover, if a sage find his time, he rises; if he does not find his time, he wanders about like a P'ung plant [which is described by the commentators to be a plant, growing on the sand and easily carried about by the wind]. I have heard, a wise merchant hides [his treasures] deeply, as if [his house or safe] were empty. A sage of perfect virtue gives himself the appearance as though [he were] simple-minded 愚 *yü*.[1]

"Give up your proud spirit, your many wishes, your external appearance with your exaggerated plans. These all are of no advantage to the sage's person. This is what I have to communicate to you, sir; that is all."

Sz'-Ma-Ts'ien continues:

"Confucius went; and he said to his disciples: 'Of the birds I know that they can fly, of the fishes I know that they can swim, of the beasts I know that they can run. For the running, one makes nooses; for the swimming, one makes nets; for the flying, one makes arrows. As to the dragon, I do not know how he rides upon wind and clouds up to heaven. To-day I saw Lao-tsz'. Is he perhaps like the dragon?'"

Confucius was more congenial to his countrymen than Lao-tsz', for he was more typically Chinese. Although his life had been an unbroken chain of disappointments, Confucius succeeded after his death in becoming the moral teacher of the Chinese people. His agnostic attitude in metaphysics and religion which neither affirms nor denies the existence of a beyond, of God, or gods, and of ghosts, but avoids investigating the matter, his unbounded reverence for the past, his respect for scholarship and book-learning, his ethics of traditionalism, which implies an extreme conservatism, his exaggeration of propriety, his ceremonialism, and above all his ideal of submission to authority have more and more become national traits of the Chinese nation.

What a pity that the weakness of China is an exaggerated virtue; it is reverence run mad—a virtue in which America is as much deficient as China is in excess.

It was characteristic of a typical Chinaman like Confucius that

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[1] Gabelentz translates 愚 *yü* by "*dumm.*" The character contains the symbols denoting "monkey" and "heart or mind." See Williams's *Syllabic Dictionary of the Chinese Language*, p. 1120.

he should have admired the Yih King solely on account of its age, because it came down to him from the sages of yore. He said:

"Should a few more years be granted to me, I shall have applied fifty to studying the Yih and thereby could be free from erring greatly."—*Lún Yü*, VII., 16.[1]

We know much more about Confucius than about any other Chinese philosopher, emperor, or saint, but it appears that he was more of a moral teacher than a philosopher or mathematician, and it is probable that the Yih King was to him a book with seven seals, the unintelligibility of which fascinated him.

Having impressed upon the nation his personality, Confucius lived on in the souls of his countrymen; and, following their master's injunction, the Chinese continued to study the Yih King without finding the solution of its problems. Instead of avoiding grave mistakes, they committed the gravest one: they relied upon traditional authority and ceased to be self-dependent. Instead of deciphering the eternal revelation of truth that surrounds us in the living book of nature and of our individual experiences, they pondered over the secret meanings of the holy Yih King; and even today there are many among them who believe that the Yih King contains all the wisdom, physical, moral, and metaphysical, that can be conceived by any of the sages of the world.[2]

The mistake of the Chinese is natural and perhaps excusable, for it is founded upon a profound, although misunderstood and misapplied, reverence for the great sages who laid the cornerstone of their civilisation. We, as outsiders, can easily appreciate the merits and reject the errors of the fundamental principles of Chinese thought; but not all of us are conscious of the fact that in many respects we too suffer from an exaggerated reverence for traditionalism.

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[1] Such is the translation according to Dr. Riedel, which, after a comparison with the original, I find, so far as I can judge, as literal as possible. Professor Legge translates: "If some years were added to my life, I would give fifty to," etc.

[2] The claim that the Yih contains all science should be interpreted in the same sense as we might declare that logic contains all possible rules of thought, and the multiplication-table is the essence of all possible numerical relations.

CONCLUSION.

Whatever may be the solution of the mystery of the Yih King, it is almost certain that the Chinese themselves do not understand it. Thus in spite of the simplicity of their philosophy of permutations, as we may briefly call the theory of constructing a world-conception from Yang and Yin elements, all their thinking, planning, and yearning is dimmed by mysticism; and the vain hope of divination fills their minds with superstitious beliefs which makes them, on the one hand, slavishly submissive to the various evils of life, and, on the other hand, self-satisfied in the belief that their sages alone are in possession of the philosophers' stone. All this renders the Chinese unfit to grasp the significance of reality, and abandons them almost hopelessly to the mercy of their own barbarous institutions, such as their antiquated penal laws and prison practices, extortionate taxation, and the arbitrary government system, to which they patiently submit.

Patience is a virtue which is much admired in China and highly praised in prose and verse, as the basis of self-control, domestic peace, and good government. We read in the famous Pih Jin Ko, the "Ode on Universal Patience":[1]

"This song of patience universal,
Of universal patience sings.

Can one be patient, summer is not hot;
Can one be patient, winter is not cold.

Can one be patient, poverty is yet happy;
Can one be patient, long life may yet be protracted.

With impatience, little evils change to great;
With impatience, a good nature at length becomes wolfish.

Kow Tseën tasted gall, and patiently waited for revenge;
Tan of Yen, from want of moderation, in the end was lost and perished.

Sze Tih, when spit upon in the face, patiently let it dry;
Tih Chaou, for want of patience, was a very dunce.

[1] See *Chinese Repository*, Vol. IX., p. 48, where the original Chinese is published together with an English translation.

The benevolent endure what other men can hardly bear;
The wise submit to what others never would endure.

To repress anger and restrain the passions is the square of patience;
To wear the petticoat,[1] and be humble, is the rule of patience.

Patience is the watchword for laying the foundation of perfection;
Patience is the watchword for forming the root of virtue.

Patience is the watchword to succeed among barbarians and savages;
Patience is the watchword to rule the violent and obstinate.

Can one bear toil and labor, one will have a superabundance:
Can one refrain from wild excess, one will be free from violent disease.

Can one forbear tattle, one will avoid slander;
Can one forbear strife and contention, one dissipates hatred and resentment.

Can one submit to abuse and raillery, one shows his caliber;
Can one bend to thorough study, one accumulates learning.

Once patient, all blessings come in company;
Once patient, every woe is burnt to ashes."

The Chinese government, and with it the Chinese nation, seem to be at present in a pitiable plight; and, indeed, their empire is like a Colossus of brass on clay feet.

Nevertheless, there is at the foundation of the Chinese civilisation and of the Chinese national character a nucleus of moral worth and intellectual capabilities which may come to the front again. To conquer China in war may be easy enough, but to compete with her children in the industrial persuits of peace may prove impossible. The conqueror often succumbs to the less noisy but more powerful virtues of the conquered. Thus Greece overcame Rome and the Saxons Anglicised the Normans. When the walls break down which separate China from the rest of the world so as to give the Chinese a chance of learning from us all they can, it is very doubtful what the result of a free competition with the Chinese will be. Their imperturbable patience, their endurance, their steadfast character, their pious reverence, their respect for learning,

[1] This phrase means "to be submissive to authority, as a wife ought to be to her husband," being the reverse of a well-known expression in English slang.

should not be underrated. If these virtues are but turned in the right direction and tempered by that breadth of mind which is indispensable for progress, the Chinese will soon recover; and nothing is more apt to produce a national rebirth than hard times, trials, and humiliations.

China is offered in her recent misfortunes the chance of a spiritual rebirth. Should she avail herself of this opportunity, she would, with her four hundred millions of inhabitants and her untold virgin resources, at once take a prominent rank among the nations of the earth; and her civilisation might become strong enough to influence and modify our own.

EDITOR.

GERMINAL SELECTION.[1]

NUMEROUS and varied are the objections that have been advanced against the theory of selection since it was first enunciated by Darwin and Wallace—from the unreasoning strictures of Richard Owen down through the acute and thoughtful counter-arguments of Albert Wigand and Nägeli to the opposition of our own day, which contends that selection cannot create but only reject, and which fails to see that precisely through this rejection its creative efficacy is asserted. The champions of this view are for discovering the motive forces of evolution in the *laws* that govern organisms—as if the norm according to which an event happens were the event itself, as if the rails which determine the direction of a train could supplant the locomotive. Of course, from every form of life there proceeds only a definite, though extremely large, number of tracks, *the possible variations*, whilst between them lie stretches without tracks, *the impossible variations*, on which locomotion is impossible. But the actual travelling of a track is not performed by the track but by the locomotive, and on the other hand, the choice of a track, the decision whether the destination of the train shall be Berlin or Paris is not made by the locomotive, the cause of the variation, but by the driver of the locomotive, who directs the engine to the right track. In the theory of selection the engine-driver is represented by utility, for with utility rests the decision as to what particular variational track shall be travelled. The cogency, the irresistible cogency, as I take it, of the principle of selection is pre-

[1] An address delivered before the International Congress of Zoölogists at Leyden, Sept. 16, 1895. (Unpublished.) Translated from Professor Weismann's manuscript by T. J. McCormack.

cisely its capacity of explaining why fit structures always arise, and that certainly is the great problem of life. Not the fact of change, but the *manner* of the change, whereby all things are maintained capable of life and existence, is the pressing question.

It is, therefore, a very remarkable fact, and one deserving of consideration, that to-day, after science has been in possession of this principle for something over thirty years and during this time has steadily and zealously busied itself with its critical elaboration and with the exact determination of its scope, that now the estimation in which it is held should apparently be on the decrease. It would be easy to enumerate a long list of living writers who assign to it a subordinate part only in evolution, or none at all. One of our youngest biologists speaks without ado of the "pretensions of the refuted Darwinian theory, so called,"[1] and one of the oldest and most talented inquirers of our time, a pioneer in the theory of evolution, who is unfortunately now gone to his rest, Thomas Huxley, implicitly yet distinctly intimated a doubt regarding the principle of selection when he said: "Even if the Darwinian hypothesis were swept away, evolution would still stand where it is." Therefore, he, too, regarded it as not impossible that this hypothesis should disappears from among the great explanatory principles by which we seek to approach nearer to the secrets of nature.

I am not of that opinion. I see in the growth of doubts regarding the principle of selection and in the pronounced and frequently bitter opposition which it encounters, a transient depression only of the wave of opinion, into which every scientific theory must descend after having been exalted, here perhaps with undue swiftness, to the highest pinnacle of recognition. It is the natural reaction from its overestimation, which is now followed by an equally exaggerated underestimation. The principle of selection was not overrated in the sense of ascribing to it too much explanatory efficacy, or of extending too far its sphere of operation, but in the sense that naturalists imagined that they perfectly understood its ways of work-

[1] Hans Driesch, *Die Biologie als selbstständige Grundwissenschaft*, Leipsic, 1893, p. 31, footnote. The sentence reads: "An examination of the pretensions of the refuted Darwinian theory, so called, would be an affront to our readers."

ing and had a distinct comprehension of its factors, which was not so. On the contrary, the deeper they penetrated into its workings the clearer it appeared that something was lacking, that the action of the principle, though upon the whole clear and representable, yet when carefully looked into encountered numerous difficulties, which were formidable, for the reason that we were unsuccessful in tracing out the actual details of the individual process, and, therefore, in *fixing* the phenomenon as it actually occurred. We can state in no single case how great a variation must be to have selective value, nor how frequently it must occur to acquire stability. We do not know when and whether a desired useful variation really occurs, nor on what its appearance depends; and we have no means of ascertaining the space of time required for the fulfilment of the selective processes of nature, and hence cannot calculate the exact number of such processes that do and can take place at the same time in the same species. Yet all this is necessary if we wish to follow out the precise details of a given case.

But perhaps the most discouraging circumstance of all is, that we can assert in scarcely a single actual instance in nature whether an observed variation is useful or not—a drawback that I distinctly emphasised some time ago.[1] Nor is there much hope of betterment in this respect, for think how impossible it would be for us to observe all the individuals of a species in all their acts of life, be their habitat ever so limited—and to observe all this with a precision enabling us to say that this or that variation possessed selective value, that is, was a decisive factor in determining the existence of the species.

In many cases we can reach at least a probable inference, and say, for example, that the great fecundity of the frog is a property having selective value, basing our inference on the observation that in spite of this fertility the frogs of a given district do not increase.

But even such inferences offer only a modicum of certainty. For who can say precisely how large this number is? Or whether it

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[1] *Die Allmacht der Naturzüchtung.* A Reply to Herbert Spencer. Jena, 1893, p. 27 et seq. [Also in the *Contemporary Review* for September, 1893.]

is on the increase or on the decrease? And besides, the exact degree of the fecundity of these animals is far from being known. Rigorously viewed, we can only say that great fecundity must be advantageous to a much-persecuted animal.

And thus it is everywhere. Even in the most indubitable cases of adaptation, as, for instance, in that of the striking protective coloring of many butterflies, the sole ground of inference that the species upon the whole is adequately adapted to its conditions of life, is the simple fact that the species is, to all appearances, preserved undiminished, and the inference is not at all permissible that just this protective coloring has selective value for the species, that is, that if it were lacking, the species would necessarily have perished.

It is not inconceivable that in many species to-day these colorings are actually unnecessary for the preservation of the species, that they formerly were, but that now the enemies which preyed on the resting butterflies have grown scarce or have died out entirely, and that the protective coloring will continue to exist by the law of inertia[1] only for a short while, till panmixia or new adaptations shall modify it.

Discouraging, therefore, as it may be, that the control of nature in her minutest details is here gainsaid us, yet it were equivalent to sacrificing the gold to the dross, if simply from our inability to follow out the details of the individual case we should renounce altogether the principle of selection, or should proclaim it as only subsidiary, on the ground that we believe the protective coloring of the butterfly is not a protective coloring but a combination of colors inevitably resulting from internal causes. The protective coloring remains a protective coloring whether at the time in question it is or is not necessary for the species; and it arose as protective coloring—arose not because it was a constitutional necessity of the animal's organism that here a red and there a white, black, or yellow spot should be produced, but because it was advantageous, because

[1] That is, by the law of exceedingly slow retrogression of superfluous characters, which may be designated the law of organic inertia.

it was necessary for the animal. There is only one explanation possible for such patent adaptations and that is selection. What is more, no other natural way of their originating is conceivable, for we have no right to assume teleological forces in the domain of natural phenomena.

I have selected the example of the butterfly's wing, not solely because it is so widely known, but because it is so exceedingly instructive, because we are still able to learn so much from it. It has been frequently asserted that the color-patterns of the butterfly's wings have originated from internal causes, independently of selection and conformably to inward laws of evolution. Eimer has attempted to prove this assertion by establishing in a division of the genus Papilio the fact that the species there admit of arrangement in series according to affinity of design. But is a proof that the markings are modified in definite directions during the course of the species's development, equivalent to a definite statement as to the *causes* that have produced these gradual transformations? Or, is our present inability to determine with exactness the biological significance of these markings and their modifications, a proof that the same have no significance whatever? On the contrary, I believe it can be clearly proved that the wing of the butterfly is a tablet on which nature has inscribed everything she has deemed advantageous to the preservation and welfare of her creatures, and nothing else; or, to abandon the simile, that these color-patterns have not proceeded from inward evolutional forces but are the result of selection. At least in all places where we do understand their biological significance these patterns are constituted and distributed over the wing exactly as utility would require.

I do not pledge myself, of course, to give an explanation of every spot and every line on a wing. The inscription is often a very complicated one, dating from remote and widely separated ages; for every single existing species has inherited the patterns of its ancestral species and that again the patterns of a still older species. Even at its origin, therefore, the wing was far from being a *tabula rasa*, but was a closely written and fully covered sheet, on which there was no room for new writing until a portion of the old

had been effaced. But other parts were preserved, or only slightly modified, and thus in many cases gradually arose designs of almost undecipherable complexity.

I should be far from maintaining that the markings arose unconformably to law. Here, as elsewhere, the dominance of law is certain. But I take it, that the laws involved, that is, the physiological conditions of the variation, here are without exception subservient to the ends of a higher power—utility; and that it is utility primarily that determines the kind of colors, spots, streaks, and bands that shall originate, as also their place and mode of disposition. The laws come into consideration only to the extent of conditioning the quality of the constructive materials—the variations, out of which selection fashions the designs in question. And this also is subject to important restrictions, as will appear in the sequel.

The meaning of formative laws here is that definite spots on the surfaces of the wings are linked together in such a manner by inner, invisible bonds, as to represent the same spots or streaks, so that we can predict from the appearance of a point at one spot the appearance of another similar point at another, and so on. It is an undoubted fact that such relations exist, that the markings frequently exhibit a certain symmetry, that—to use the words of the most recent observer on this subject, Bateson[1]—a meristic representation of equivalent design-elements occurs. But I believe we should be very cautious in deducing laws from these facts, because all the rules traceable in the markings apply only to small groups of forms and are never comprehensive nor decisive for the entire class or even for the single sub-class of diurnal butterflies, in fact, often not so for a whole genus. All this points to special causes operative only within this group.

If internal laws controlled the markings on butterflies' wings, we should expect that some general rule could be established, requiring that the upper and under surfaces of the wings should be

[1] *Materials for the Study of Variation with Especial Regard to Discontinuity in the Origin of Species.* London, 1895.

alike or that they should be different, or that the fore wings should be colored the same as or differently from the hind wings, etc. But in reality all possible kinds of combinations occur simultaneously, and no rule holds throughout. Or, it might be supposed that bright colors should occur only on the upper surface or only on the under surface, or on the fore wings or only on the hind wings. But the fact is, they occur indiscriminately, now here, now there, and no one method of appearance is uniform throughout all the species. But the fitness of the various distributions of colors is apparent, and the moment we apply the principle of utility we know why in the diurnal butterflies the upper surface alone is usually variegated and the under surface protectively colored, or why in the nocturnal butterflies the fore wings have the appearance of bark, of old wood, or of a leaf, whilst the hind wings, which are covered when resting, alone are brilliantly colored. On this theory we also understand the exceptions to these rules. We comprehend why Danaids, Heliconids, Euploids, and Acracids, in fact all diurnal butterflies, offensive to the taste and smell, are mostly brightly marked and equally so on both surfaces, whilst all species not thus exempt from persecution have the protective coloring on the under surface and are frequently quite differently colored there from what they are on the upper.

In any event, the supposed formative laws are not obligatory. Dispensations from them can be issued and are issued *whenever utility requires it.* Indeed, so far may these transgressions of the law extend, that in the very midst of the diurnal butterflies is found a genus, the South American Ageronia, which, like the nocturnal butterfly, shows on the entire *upper* surface of both wings a pronounced bark-coloration, and concerning which we also know, (and in this respect it is an isolated genus and differs from almost all other diurnal butterflies,) that it spreads out its wings when at rest like the nocturnal butterfly, and does not close them above it as its relatives do. Therefore, entirely apart from cases of mimicry, which after all constitute the strongest proof, the facts here cited are alone sufficient to remove all doubt that not inner necessities or so-called form-

ative laws have painted the surface of the butterflies' wings, but that the conditions of life have wielded the brush.

This becomes more apparent on considering the details. I have remarked that the usually striking colorations of exempt butterflies, as of the Heliconids, are the same on both the upper and the lower surfaces of the wings. Possibly the expression of a law might be seen in this fact, and it might be said, the coloration of the Heliconids *runs through* from the upper to the under surface. But among numerous imitators of the Heliconids is the genus Protogonius, which has the coloration of the Heliconids on its upper surface, but on its lower exhibits a magnificent leaf-design. During flight it appears to be a Heliconid and at rest a leaf. How is it possible that two such totally different types of coloration should be combined in a single species, if any sort of *inner* rigorous necessity existed, regulating the coloration of the two wing-surfaces? Now, although we are unable to prove that the Protogonius species would have perished unless they possessed this duplex coloration, yet it would be nothing less than intellectual blindness to deny that the butterflies in question are effectively protected, both at rest and during flight, *that their colorations are adaptive.* We do not know their primitive history, but we shall hardly go astray if we assume that the ancestors of the Protogonius species were forest-butterflies and already possessed an under surface resembling a leaf. By this device they were protected when at rest. Afterwards, when this protection was no longer sufficient, they acquired on their upper surface the coloration of the exempt species with which they most harmonised in abode, habits of life, and outward appearance.

At the same time it is explained why these butterflies did not acquire the coloration of the Heliconids on the under surface. The reason is, that in the attitude of repose they were already protected, and that in an admirable manner.

That *exempt* diurnal butterflies should be colored on the upper and under surfaces alike, and should never resemble in the attitude of repose their ordinary surroundings, is intelligible when we reflect that it is a much greater protection to be despised when discovered

than to be well, or very well, but never absolutely, protected from discovery.

It has been so often reiterated that diurnal butterflies, as a rule, are protectively colored on the under surfaces, that one has some misgivings in stating the fact again. And yet the least of those who hold this to be a trivial commonplace know how strongly its implications militate against the inner motive and formative forces of the organism, which are ever and anon appealed to. No less than sixty-two genera are counted to-day in the family of diurnal butterflies known as the Nymphalidæ. Of these by far the largest majority are sympathetically colored underneath, that is, they show in the posture of rest the colorings of their usual environment. In a large number of the species belonging to this group the entire surface of the hind wings possesses such a sympathetic coloration, as does also the distant apex of the fore wings. Why? The reason is obvious. This part only of the fore wing is visible in the attitude of repose. Here, then,—as a zealous opponent of the theory of selection once exclaimed,—there is undoubted "correlation" between the coloring of the surface of the hind wing and of the apex of the fore wing. Correlation is unquestionably a fine word, but in the present instance it contributes nothing to the understanding of the problem, for there are near relatives and often species of the same genera in which this correlation is not restricted to the apex of the fore wings, but extends to a third or even more of their wings, and these species are also in the habit of drawing back their wings less completely in the state of rest, thus rendering a larger portion of them visible. There are species, too, like the forest-butterflies of South America just mentioned, the Protogonius, Anæa, Kallima species, etc., which have nearly the *whole* of the under surfaces of their fore wings marked according to the same pattern with their hind wings, and these butterflies when at rest hold their fore wings free and uncovered by their hind wings. Where are the formative laws in such cases?

Or, perhaps some one will say: "The covering by the hind wings hinders the formation of scales on the wing, or impedes the formation of the colors in the scales." Such a person should exam-

ine one of these species. He will find that the scales are just as dense on the covered as on the uncovered surface of the wing, and in many species, for example, in Katagramma, the scales of the covered surface are colored most brilliantly of all.

But the facts are still more irresistible, when we consider *special adaptations*; for example, the imitation of leaves, which is so often cited. It is to be noted, first, that this sort of imitation is by no means restricted to a few genera, still less to a few species. All the numerous species of the genus Anæa, which are distributed over the forests of tropical South America, exhibit this imitation in pronounced and varied forms, as do likewise the American genera Hypna and Siderone, the Asiatic Symphaedra, the African Salamis, Eurypheme, etc. I have observed fifty-three genera in which it is present in one, several, or in many species, but there are many others.

These genera, now, are by no means all so nearly allied that they could have inherited the leaf-markings from a common ancestral form. They belong to different continents and have probably for the most part acquired their protective colorings themselves. But one resemblance they have in common—they are all *forest-butterflies.* Now what is it that has put so many genera of forest-butterflies and no others into positions where they could acquire this resemblance to leaves? Was it directive formative laws? If we closely examine the markings by which the similarity of the leaf is determined, we shall find, for example, in Kallima Inachis, and Parallecta, the Indian leaf-butterflies, that the leaf-markings are executed *in absolute independence of the other uniformities governing the wing.*

From the tail of the wing to the apex of the fore wings runs with a beautiful curvature a thick, doubly-contoured dark line accompanied by a brighter one, representing the midrib of the leaf. This line cuts the "veins" and the "cells" of the leaf in the most disregardful fashion, here in acute and here in obtuse angles, and in absolute independence of the regular system of divisions of the wing, which should assuredly be the expression of the "formative law of the wing," if that were the product of an internal directive principle. But leaving this last question aside, this much is certain

with regard to the markings, that they are dependent, not on an *internal*, but on an *external* directive power.

Should any one be still unconvinced by the evidence we have adduced, let him give the leaf-markings a closer inspection. He will find that the midrib is composed of two pieces of which the one belongs to the hind wing and the other to the fore wing, and that the two fit each other exactly when the butterfly is in the attitude of repose, but not otherwise. Now these two pieces of the leaf-rib do not begin on corresponding spots of the two wings, but on absolutely non-identical spots. And the same is also true of the lines which represent the lateral ribs of the leaf. These lines proceed in acute angles from the rib; to the right and to the left in the same angle, those of the same side parallel with each other. Here, too, no relation is noticeable between the parts of the wings over which the lines pass. The venation of the wing is utterly ignored by the leaf-markings, and its surface is treated as a *tabula rasa* upon which anything conceivable can be drawn. In other words, we are presented here with a *bilaterally symmetrical* figure engraved on a surface which is essentially *radially symmetrical* in its divisions.

I lay unusual stress upon this point because it shows that we are dealing here with one of those cases which cannot be explained by mechanical, that is, by natural means, unless natural selection actually exists and is actually competent to create new properties; for the Lamarckian principle is excluded here *ab initio*, seeing that we are dealing with a formation which is only passive in its effects: the leaf-markings are effectual simply by their existence and not by any function which they perform; they are present in flight as well as at rest, during the absence of a danger, as well as during the approach of an enemy.

Nor are we helped here by the assumption of *purely internal motive forces*, which Nägeli, Askenasy, and others have put forward as supplying a *mechanical* force of evolution. It is impossible to regard the coincidence of an Indian butterfly with the leaf of a tree now growing in an Indian forest as fortuitous, as a *lusus naturæ*. Assuming this seemingly mechanical force, therefore, we should be led back inevitably to a teleological principle which produces adap-

tive characters and which must have deposited the directive principle in the very first germ of terrestrial organisms, so that after untold ages at a definite time and place the illusive leaf-markings should be developed. The assumption of pre-established harmony between the evolution of the ancestral line of the tree with its prefigurative leaf, and that of the butterfly with its imitating wing, is absolutely necessary here, as I pointed out many years ago,[1] but as is constantly forgotten by the promulgators of the theory of internal evolutionary forces.

For the present I leave out of consideration altogether the question as to the conceivable extent of the sphere of operation of natural selection; I am primarily concerned only with elucidating the process of selection itself, wholly irrespective of the comprehensiveness or limitedness of its sphere of action. For this purpose it is sufficient to show, as I have just done, *that cases exist wherein all natural explanations except that of selection fail us.* But let us now see how far the principle of selection will carry us in the explanation of such cases—natural selection, I mean, as it was formulated by Darwin and Wallace.

There can be no doubt but the leaf-markings readily admit of production in this manner, slowly and with a gradual but constant increase of fidelity, provided a single condition is fulfilled: *the occurrence of the right variations at the right place.* But just here, it would seem, is the insurmountable barrier to the explanatory power of this principle, for who, or what, is to be our guarantee that dark scales shall appear at the exact spots on the wing where the midrib of the leaf must grow? And that later dark scales shall appear at the exact spots to which the midrib must be prolonged? And that still later such dark scales shall appear at the places whence the lateral ribs start, and that here also a definite acute angle shall be accurately preserved, and the mutual distances of the lateral ribs be alike and their courses parallel? And that the prolongation of the median rib from the hind wing to the fore wing shall be ex-

[1] *Studien zur Descendenstheorie*, Leipsic, 1876. Vol. II, pp. 295 and 322.

tended exactly to that spot where the fore wing is not covered by the hind wing in the attitude of repose? And so on.

If I could go more minutely into this matter, I should attempt to prove that the markings, as I have just assumed, have not risen suddenly, but were perfected very, very, gradually; that in one species they began on the fore wing and in another on the hind wing; and that in many they never until recently proceeded beyond one wing, in other species they went only a little way, and in only a few did they spread over the entire surface of both wings.

That these markings advanced slowly and gradually, but with marvellous accuracy, is no mere conjecture. But it follows that the right variations at the right places must never have been wanting, or, as I expressed it before: *the useful variations were always present.* But how is that possible in such long extensive lines of dissimilar variations as have gradually come to constitute markings of the complexity here presented? Suppose that the useful colors had not appeared at all, or had not appeared at the right places? It is a fact that in constant species, that is, in such as are not in process of transformation, the variations of the markings are by no means frequent or abundant. Or, suppose that they had really appeared, but occurred only in individuals, or in a small percentage of individuals?

Such are the objections raised against the theory of selection by its opponents, and put forward as insurmountable obstacles to the process. Nor are such objections relevant only in the case of protective colorings; they are applicable in all cases where the process of selection is concerned. Take the case of instincts that are called into action only once in life, as, for example, the pupal performances of insects, the artificial fabrication of cocoons, etc. How is it that the useful variations were always present here? And yet they must have been present, if such complicated spinning instincts could have taken their rise as are observable in the silk-worm, or in the emperor-moth. And they have been developed, and that in whole families, in forms varying in all species, and in every case adapted to the special wants of the species.

Particularly striking is the proof afforded of this constant pres-

ence of the useful variations by cases where we meet with the development of highly special adaptations that are uncommon even for the group of organisms concerned. Such a case, for example, is the apparatus designed for the capture of small animals and their digestion, found in widely different plants and widely separated families. On the other hand, very common adaptations, such as the eyes of animals, show distinctly that in all cases where it was necessary, the useful variations for the formation of an eye were presented, and were presented further exactly at spots at which organs of vision could perform their best work: thus, in Turbellaria and many other worms that live in the light, at the anterior extremity of the body and on the dorsal surface; in certain mussels, on the edge of the mantle; in terrestrial snails, on the antennæ; in certain tropical marine snails, inhabiting shallow waters, on the back; and in the chitons even on the dorsal surface of the shell!

But even taking the very simplest cases of selection, it is impossible to do without this assumption, that the useful variations are always present, or that *they always exist in a sufficiently large number of individuals for the selective process.* You know the thickness and power of resistance of the egg-shells of round-worms. The eggs of the round-worms of horses have been known to continue their course of development undisturbed even after they had been thrown into strong alcohol and all other kinds of injurious liquids—much to the vexation of the embryologists, who wished to preserve a definite stage of development and sought to kill the embryo at that stage. Indeed, think of the result, if in the course of their phylogenesis stout and resistant variations of egg-shells had not been presented in these worms, or had not always been presented, or had not been presented in every generation and not in sufficient quantities.

The cogency of the facts is absolutely overpowering when we consider that practically no modification occurs *alone*, that every primary modification brings in its train secondary ones, and that these induce forced modifications in many parts of the body, frequently of the most diversified, or even self-contradictory, forms. Recently Herbert Spencer has drawn fresh attention to these sec-

ondary modifications, which must always occur in harmony with the primary one, and has, as he thinks, advanced in this set of facts, a convincing disproof of the contention that such coadaptive modifications of numerous cofunctioning parts can rest on natural selection. Now, although I deem his conclusion precipitate, yet the very fact of a simultaneous, functionally concordant, yet essentially diversified modification of numerous parts, points conclusively to the circumstance that *something is still wanting to the selection of Darwin and Wallace, which it is obligatory on us to discover, if we possibly can,* and without which selection as yet offers no complete explanation of the phyletic processes of transformation. There is a hidden secret to be unriddled here before we can obtain a satisfactory insight into the phenomena in question. *We must seek to discover why it happens that the useful variations are always present.*

Herbert Spencer appealed to Lamarck's principle for the explanation of coadaptation, and it is certain that functional adaptation is operative during the individual life, and that it compensates in a certain measure the inequalities of the inherited constitutions. I shall not repeat what I have said before on this subject, nor maintain, in refutation of Spencer's contention, that functional adaptation is itself nothing else than the efflux of *intra-biontic* selective processes, as Spencer himself once suggested in a prophetic moment, but which it was left for Wilhelm Roux to introduce into science as "the struggle of the parts" of organisms.[1] I shall only remark that if functional adaptations were themselves inheritable, this would still be insufficient for the explanation of coadaptation, for the reason that precisely similar coadaptive modifications occur in *purely passively* functioning parts, in which, consequently, modification *by* function is excluded. This is the case with the skeletal parts of Articulata; e. g., it is true of their articular surfaces with their complex adaptations to the most varied forms of locomotion. In all these cases the ready-made, hard, unalterable, chitinous part is *first* set into activity; consequently its adaptation to the function must have

[1] Compare my essay, *Neue Gedanken zur Vererbungsfrage*, Jena, 1895, p. 10, second footnote.

been *previously* effected, independently of that function. These joints, and divers other parts, accordingly, have been developed in the precisest manner for the function, and the latter could have had no direct share in their formation. When we consider, now, that it is impossible that every one of the numerous surfaces, ridges, furrows, and corners found in a single such articulation, let alone in all the articulations of the body, should hold in its hands the power of life and death over individuals for untold successions of generations, the fact is again unmistakably impressed upon our attention that the conception of the selective processes which has hitherto obtained is insufficient, that the root of the process in fact lies deeper, that it is to be found in the place where it is determined what variations of the parts of the organism shall appear—namely, *in the germ.*

The phenomena observed in the *stunting*, or *degeneration, of parts rendered useless*, point to the same conclusion. They show distinctly that ordinary selection which operates by the removal of entire persons, *personal selection*, as I prefer to call it, cannot be the only cause of degeneration; for in most cases of degeneration it cannot be assumed that slight individual vacillations in the size of the organ in question have possessed selective value. On the contrary, we see such retrogressions effected apparently *in the shape of a continuous evolutionary process determined by internal causes*, in the case of which there can be no question whatever of selection of persons or of a survival of the fittest, that is, of individuals with the smallest rudiments.

It is this consideration principally that has won so many adherents for the Lamarckian principle in recent times, particularly among the paleontologists. They see the outer toes of hoofed animals constantly and steadily degenerating through long successions of generations and species, concurrently with the re-enforcement of one or two middle toes, which are preferred or are afterwards used exclusively for stepping, and they believe correctly enough that these results should not be ascribed to the effects of personal selection alone. They demand a principle which shall effect the degeneration by internal forces, and believe that they have found it in func-

tional adaptation.[1] On this last point, now, I believe, they are mistaken, be they ever so strongly convinced of the correctness of their view and ever so aggressive and embittered in their defence of it.

Recently, an inquirer of great caution and calmness of judgment, Prof. C. Lloyd Morgan, has expressed the opinion that the Lamarckian principle must at least be admitted as a working hypothesis. But with this I cannot agree, at least as things stand at present. A working hypothesis may be false, and yet lead to further progress; that is, it may constitute an advance to the extent of being useful in formulating the problem and in illuminating paths that are likely to lead to results. But it seems to me that a hypothesis of this kind has performed its services and must be discarded the moment it is found to be at hopeless variance with the facts. If it can be proved that precisely the same degenerative processes also take place in such superfluous parts as have only *passive* and not active functions, as is the case with the *chitinous parts of the skeleton of Arthropoda*, then it is a demonstrated fact, that the cessation of functional action is not the efficient cause of the process of degeneration. At once your legitimate working hypothesis is transformed into an illegitimate dogma—illegitimate because it no longer serves as a guide on the path to knowledge but blocks that path. For the person who is convinced he has found the right explanation is not going to seek for it.

[1] On the same day on which the present address was delivered at the International Congress of Zoölogists in Leyden, and on the same occasion, Dr. W. B. Scott, Professor of Geology in Princeton College, New Jersey, read a very interesting paper on the tertiary mammalian fauna of North America, in which, without a knowledge of my paper, he took his stand precisely on this argument and arrived at the opinion that it could not possibly be the ordinary individual variations which accomplished phyletic evolution, but that it was necessary to assume in addition phyletic variations. I believe our views are not as widely remote as might be supposed. Of course, I see no reason for assuming two kinds of hereditary variations, different *in origin*. Still it is likely that only a relatively small portion of the numberless individual variations lie on the path of phyletic advancement and so under the *guidance* of germinal selection mark out the way of further development; and hence it would be quite possible in this sense to distinguish continuous, *definitely directed* individual variations from such as fluctuate hither and thither with no uniformity in the course of generations. The root of the two is of course the same, and they admit of being distinguished from each other only by their success, phyletic modification, or by their failure.

I can understand perfectly well the hesitation that has prevailed on this point in many minds, from their having seen *one* aspect of the facts more distinctly than the other. From this sceptical point of view Osborn has drawn the following perfectly correct conclusion: "If acquired variations are transmitted, there must be some unknown principle in heredity; if they are not transmitted, there must be some unknown factor in evolution."[1]

Such in fact is the case and I shall attempt to point out to you what this factor is. My inference is a very simple one: if we are forced by the facts on all hands to the assumption that the useful variations which render selection possible are always present, then, *some profound connexion must exist between the utility of a variation and its actual appearance*, or, in other words, *the direction of the variation of a part must be determined by utility*, and we shall have to see whether facts exist that confirm our conjecture.

The facts do indeed exist and lie before our very eyes, despite their not having been recognised as such before. All *artificial selection* practised by man rests on the fact that by means of the selection of individuals having a given character slightly more pronounced than usual, there is gradually produced a general augmentation of this character, which subsequently reaches a point never before attained by any individual of this species. I shall choose an example which seems to me especially clear and simple because only one character has been substantially modified here. The long-tailed variety of domestic cock, now bred in Japan and Corea, owes its existence to skilful selection and not at all to the circumstance that at some period of the race's history a cock with tail-feathers six feet in length suddenly and spasmodically appeared. At the present day even, as Professor Ischikawa of Tokio writes me, the breeders still make extraordinary efforts to increase the length of the tail, and every inch gained adds considerably to the value of the bird. Now nothing has been done here whatever except to select for purposes of breeding always the cocks with the

[1] H. F. Osborn, "The Hereditary Mechanism and the Search for the Unknown Factors of Evolution," in *Biological Lectures delivered at the Marine Biolog. Lab. at Wood's Holl in the Summer Session of 1894.* Boston, 1895.

longest feathers; and in this way alone were these feathers, after the lapse of many generations, prolonged to a length far exceeding every previous variation.

I once asked a famous dove-fancier, Mr. W. B. Tegetmeier of London, whether it was his opinion that by artificial selection alone a character could be augmented. He thought a long time and finally said: "It is without our power to do anything if the variation which we seek is not presented, but once that variation is given, then I think the augmentation can be effected." And that in fact is the case. If cocks had never existed whose tail-feathers were a little longer than usual the Japanese breed could never have originated; but as the facts are, always the cocks with the longest feathers were chosen from each generation, and these only were bred, and thus a hereditary augmentation of the character in question was effected, which would hardly have been deemed possible.

Now what does this mean? Simply that the hereditary diathesis, the germinal constitution (the *Anlage*) of the breed was changed in the respect in question, and our conclusion from this and numerous similar facts of artificial selection runs as follows: *by the selection alone of the plus or minus variations of a character is the constant modification of that character in the plus or minus direction determined.* Obviously the hereditary *diminution* of a part is also effected by the simple selection of the individuals in each generation possessing the smallest parts, as is proved, for example, by the tiny bills and feet of numerous breeds of doves. We may assert, therefore, in general terms: a definitely directed progressive variation of a given part is produced by continued selection in that definite direction. This is no hypothesis, but a direct inference from the facts and may also be expressed as follows: *By a selection of the kind referred to the germ is progressively modified in a manner corresponding with the production of a definitely directed progressive variation of the part.*

In this general form the proposition is not likely to encounter opposition, as certainly no one is prepared to uphold the view that the germ remains unchanged whilst the products proceeding from it, its descendants, are modified. On the contrary, all will agree

when I say that the germ in this case must have undergone modifications, and that their character must correspond with the modifications undergone by its products. Thus far, then, we find ourselves, not on the ground of the hypothesis that has been lately so much maligned, but on the ground of facts and of direct inferences from facts. But if we attempt to pierce deeper into the problem, we are in need of the hypothesis.

The first and most natural explanation will be this—that through selection the zero-point, about which, figuratively speaking, the organ may be said to oscillate in its plus and minus variations, is displaced upwards or downwards. Darwin himself assumed that the variations oscillated about a mean point, and the statistical researches of Galton, Weldon, and others have furnished a proof of the assumption. If selection, now, always picks out the plus variations for imitation, perforce, then, the mean or zero point will be displaced in the upward direction, and the variations of the following generation will oscillate about a higher mean than before. This elevation of the zero-point of a variation would be continued in this manner until the total equilibrium of the organism was in danger of being disturbed.

There is involved here, however, an assumption which is by no means self-evident, that every advancement gained by the variation in question constitutes a new centre for the variations occurring in the following generation. *That this is a fact*, is proved by such actual results of selection as are obtained in the case of the Japanese cock. But the question remains, Why is this the fact?

Now here, I think, my theory of determinants gives a satisfactory answer. According to that theory every independently and hereditarily variable part is represented in the germ by a *determinant*, that is, by a determinative group of vital units, whose size and power of assimilation correspond to the size and vigor of the part. These determinants multiply, as do all vital units, by growth and division, and necessarily they increase rapidly in every individual, and the more rapidly the greater the quantity of the germinal cells the individual produces. And since there is no more reason for excluding irregularities of passive nutrition, and of the supply

of nutriment in these minute, microscopically invisible parts, than there is in the larger visible parts of the cells, tissues, and organs, consequently the descendants of a determinant can never all be exactly alike in size and capacity of assimilation, but they will oscillate in this respect to and fro about the maternal determinant as about their zero-point, and will be partly greater, partly smaller, and partly of the same size as that. In these oscillations, now, the material for further selection is presented, and in the inevitable fluctuations of the nutrient supply I see the reason why every stage attained immediately becomes the zero-point of new fluctuations, and consequently why the size of a part can be augmented or diminished by selection without limit, solely by the displacement of the zero-point of variation as the result of selection.

We should err, however, if we believed that we had penetrated to the root of the phenomenon by this insight. There is certainly some other and mightier factor involved here than the simple selection of persons and the consequent displacement of the zero-point of variation. It would seem, indeed, as if in one case, *videlicet*, in that of the Japanese cock, the augmentation of the character in question were completely explained by this factor *alone*. In fact, in this and similar cases we cannot penetrate deeper into the processes of variation, and therefore cannot say *a priori* whether other factors have or have not been involved in the augmentation of the character in question—other characters, that is, than the simple displacement of the zero-point. There is, however, another class of phyletic modifications, which point unmistakably to the conclusion that the displacement of the zero-point of variation by personal selection is not and cannot be the only factor in the determination and accomplishment of the direction of variation. I refer to *retrogressive development*, the gradual degeneration of parts or characters that have grown useless, the gradual disappearance of the eye in cave-animals, of the legs in snakes and whales, of the wings in certain female butterflies, in short, that entire and enormous mass of facts comprehended under the designation of "rudimentary organs."

I have endeavored on a previous occasion to point out the significance of the part played in the great process of animate evolu-

tion by these retrogressive growths, and I made at the time the statement that "the phenomena of retrogressive growth enabled us in a greater measure almost than those of progressive growth to penetrate to the causes which produce the transformations of animate nature." Although at that time[1] I had no inkling of certain processes which I shall seek to-day to prove the existence of, yet my statement receives a fresh confirmation from these facts.

For in most retrogressive processes *active* selection in Darwin's sense plays no part, and advocates of the Lamarckian principle, as above remarked, have rightly denied that active selection, that is, the selection of individuals possessing the useless organ in its most reduced state, is sufficient to explain the process of degeneration. I, for my part, have never assumed this, and have on this very account enunciated the *principle of panmixia*. Now, although this, as I have still no reason for doubting, is a perfectly correct principle, which really does have an essential and indispensable share in the process of retrogression, still it is not *alone* sufficient for a full explanation of the phenomena. My opponents, in advancing this objection, were right, to the extent indicated, and as I expressly acknowledge, although they were unable to substitute anything positive in its stead or to render my explanation complete. The very fact of the cessation of control over the organ is sufficient to explain its *degeneration*, that is, its deterioration, the disharmony of its parts, but not the fact which actually and always occurs where an organ has become useless—viz., *its gradual and unceasing diminution continuing for thousands and thousands of years and culminating in its final and absolute effacement.*

If, now, neither the selection of persons nor the cessation of personal selection can explain this phenomenon, assuredly some other principle must be the efficient cause here, and this cause I believe I have indicated in an essay written at the close of last year and only recently published.[1] I call it *germinal selection.*

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[1] In 1886. See my paper on "Retrogression in Nature," published in English in Nos. 105, 107, 108, and 109 of *The Open Court*, and also in my essays on *Heredity*, Jena, 1892.

[2] *Neue Gedanken zur Vererbungsfrage*, Jena, 1895.

The principle in question reposes on the application, made some fifteen years ago by Wilhelm Roux, of the principle of selection to the *parts* of organisms—on the *struggle of the parts*, as he called it. If such a struggle obtains among organs, tissues, and cells, it must also obtain between the smallest and for us invisible vital particles, not only between those of the body-cells, strictly so called, but also between those of the germinal cells. Roux himself spoke of the struggle of the molecules, by which he presumably understood the smallest ultimate units of vital phenomena—elements which De Vries designated pangenes, Wiesner plasomes, and I *biophores*, after Brücke's ingenious conception[1] of these invis-

[1] Delâge, in *La structure du protoplasma et les théories sur l'hérédité*, etc., Paris, 1895, is mistaken in attributing to Herbert Spencer the merit of first having pointed out the necessity of the assumption of biological units ranking between the molecule and the cell. Brücke set forth this idea three years previously to Spencer and established it exhaustibly in a paper which in Germany at least is famous ("Elementarorganismen," *Wiener Sitzungsberichte*, October 10, 1861, Vol. XLIV., II., p. 381). Spencer's *Principles of Biology* appeared between 1864 and 1868; consequently there can be no dispute touching the priority of the idea. Strangely enough Delâge cites Brücke's essay in the Bibliographical Index at the end of his book correctly, although Brücke's name and views are nowhere mentioned in the book itself. It is to be observed, however, that the elementary organisms of Brücke are not merely the precursors of Spencer's "physiological units," but repose on much firmer foundations than the latter, which, as Delâge himself remarks, are at bottom nothing more than magnified molecules and not combinations of different molecules of such character as to produce necessarily phenomena of life. He aptly remarks on this point: "the physiological units of Spencer are only chemical molecules of greater complexity than the rest, and as he defines them they would be regarded as such by every chemist. He attributes to them no property *essentially* different from those of chemical molecules." Assimilation, growth, propagation, in short the attributes of life, are not attributed by Spencer to his units, while Brücke in his very designation "elementary organisms" expresses the idea of "ultimate living units," to use Wiesner's phrase. Of course this particular aspect of the vital units was not emphasised by Brücke with the same distinctness and sharpness as by recent inquirers, who took up Brücke's ideas thirty years after. I refer to the conception that the union of a definite combination of heterogeneous molecules into an invisibly small unit, forms the cradle or focus of the vital phenomena. This was first done and apparently on independent considerations by De Vries, and soon after by Wiesner, and subsequently by myself (De Vries, *Intracelluläre Pangenesis*, Jena, 1889; Wiesner, *Die Elementarstructur und das Wachsthum der lebenden Substanz*, Vienna, 1892; Weismann, *Das Keimplasma*, Jena, 1892). Let me say at the close of this note that it is not my intention in thus defending the rights of a great physiologist, to censure in the least the distinguished author of *L'hérédite* who has set himself a remarkably high standard of exactitude in such matters. Cer-

ible entities had been almost totally forgotten, or at least had lain unnoticed for thirty years. No struggle, as that is understood in the theory of selection, could take place between real molecules, as molecules are neither nourished, subject to growth, nor propagated.

The gradual degeneration of organs grown useless may be explained, now, by the theory of determinants very simply and without any co-operation on the part of active personal selection, as follows.

Nutrition, it is known, is not merely a passive process. A part is not only *nourished* but also actively *nourishes* itself, and the more vigorously, the more powerful and capable of assimilation it is. Hence powerful determinants in the germ will absorb nutriment more rapidly than weaker determinants. The latter, accordingly, will grow more slowly and will produce weaker descendants than the former.

Let us assume, now, that a part of the body, say the hinder extremity of the quadruped ancestors of our common whales, are rendered useless. Panmixia steps in, that is, selection ceases to influence this organ. Individuals with large and individuals with small hind legs are equally favored in the struggle for existence.

From this fact alone would result a degradation of the organ, but of course it would not be very marked in extent, seeing that the minus variations which occur are now no longer removed. According to our assumption, however, such minus variations repose on the weaker determinants of the germ, that is, on such as absorb nutriment less powerfully than the rest. And since every determinant battles stoutly with its neighbors for food, that is, takes to itself as much of it as it can, consonantly with its power of assimilation and proportionately to the nutrient supply, therefore the unimpoverished neighbors of this minus determinant will deprive it of its nutriment more rapidly than was the case with its more robust ancestors; hence, it will be unable to obtain the full quantum of food corresponding even to its weakened capacity of assimilation,

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tainly, when we consider the enormous extent of the literature that had to be mastered to produce a book embracing all the various theories of recent times, such an oversight is quite excusable.

and the result will be that its ancestors will be weakened still more. Inasmuch, now, as no weeding out of the weaker determinants of the hind leg by personal selection takes place on our hypothesis, inevitably the average strength of this determinant must slowly but constantly diminish, that is, the leg must grow smaller and smaller until finally it disappears altogether. The determinants[1] of the useless organ are constantly at a disadvantage as compared with the determinants of their environment in the germinal tenement, because no assistance is offered to them by personal selection after they have once been weakened by a decrease of the passive nutrient influx. Nor is the degeneration stopped by the uninterrupted crossing of individuals in sexual propagation, but only slightly retarded. The number of individuals with weaker determinants must, despite this fact, go on increasing from generation to generation, so that soon every determinant that still happens to be endowed with exceptional vigor will be confronted by a decided overplus of weaker determinants, and by continued crossing therefore will become more and more impoverished. Panmixia is the indispensable precondition of the whole process; for owing to the fact that persons with weak determinants are just as capable of life as those with strong, owing to the fact that they cannot now, as formerly, when the organ was still useful, be removed by personal selection, solely by this means is a further weakening effected in the following generations—in short, only by this means are the determinants of the useless organ brought upon the inclined plane, down which they are destined slowly but incessantly to slide towards their complete extinction.

The foregoing explanation will be probably accepted as satisfactory *in a purely formal regard*, but it will be objected that, even granting this, it has not yet been proved to be the correct one. In answer I can of course adduce nothing except that it is at present the only one that can be given. It may be that the actual state of

[1] I speak here of determinants, not of groups of determinants, which is the more correct expression, merely for the sake of brevity. It is a matter of course that a whole extremity, such as we have here chosen, cannot be represented in the germ by a single determinant only, but requires a large group of determinants.

things in nature is different, but if it can be shown that a self-direction of variation merely from the need of it is at all conceivable by mechanical means, that in itself, it seems to me, is a decided gain. It must also not be forgotten that some process or other *must* take place in the germ-plasm when an organ becomes rudimentary, and that as the result of it this organ, and only this organ, must disappear. Now in what shall this process consist, if not in a modification of the constitution of the germ? And how could the effect of such a modification be limited only to *one* organ which was becoming rudimentary, if the modification itself were not a local one? These are questions which it is incumbent on those to answer who conceive the germinal substance to be composed of like units.

Applying, now, the explanation derived from the disappearance of organs to the opposed transformation, namely, to the *enlargement* of a part, the presumption lies close at hand that the production of the long tail-feathers of the Japanese cock does not repose solely on the displacement directly effected by personal selection, of the zero-point of variation upwards, but that *it is also fostered and strengthened by germinal selection.* Were that not so, the phenomena of the transmutation of species, in so far as fresh growth and the enlargement and complication of organs already present are concerned, *would not be a whit more intelligible than they were before.* We should know probably how it comes to pass that the constitutional germinal elements (groups of determinants) of a *single* organ are intensified by selection, but the flood of objections against the theory of selection touching its inability to modify *many* parts at once would not be repressed by such knowledge. The initial impulse conditioning the independent maintenance of the useful direction of variation in the germ-plasm must rather be sought in the utility of the modification itself, and this also seems to me intelligible from the side of the theory. For as soon as personal selection favors the more powerful variations of a determinant, the moment that these come to predominate in the germ-plasm of the species, at once the tendency must arise for them to vary *still more strongly* in the plus direction, not solely because the zero-point has been pushed further upwards, but because they themselves now oppose a relatively more

powerful front to their neighbors, that is, actively absorb more nutriment, and upon the whole increase in vigor and produce more robust descendants. From the relative vigor or dynamic status of the particles of the germ-plasm, thus, will issue spontaneously an ascending line of variation, precisely as the facts of evolution require. For, as I have already said, it is not sufficient that the augmentation of a character should be brought about by uninterrupted personal selection, even supposing that the displacement of the zero-point were possible without germinal selection.

Thus, I think, may be explained how personal selection imparts the initial impulse to processes in the germ-plasm, which, when they are once set agoing, persist of themselves in the same direction, and are, therefore, in no need of the continued supplementary help of personal selection, *as directed exclusively to a definite part.* If but from time to time, that is, if upon the average the poorest individuals, the bearers of the weakest determinants, are eliminated, the variational direction of the part in question, now reposing on germinal selection, must persist, and it will very slowly but very surely increase until further development is impeded by its inutility and personal selection arrests the process, that is, ceases to eliminate the weaker individuals.

In this manner it becomes intelligible how a large number of modifications varying in kind and far more so in degree can be guided *simultaneously* by personal selection; how in strict conformity with its adaptive wants every part is modified, or preserved unmodified; how a given articulation can undergo modifications, causing it to disappear on one side, to grow in volume on another, and to continue unaltered on a third. For every part that is perfectly adapted, although it can fluctuate slightly, yet can never undergo a permanent alteration in the ascending or descending direction because every plus and every minus variation which has attained selective value would be eliminated by personal selection in the course of time. Therefore, a definite direction of variation cannot arise in such cases and we have also reached, as it seems to me, a satisfactory explanation of the *constancy* of well-adapted species and characters.

Hitherto I have spoken only of plus and minus variation. But there exist, as we know, not only variations of size but also variations of *kind*; and the coloration of the wings of butterflies, which we chose above as our example, would fall, according to the ordinary usage of speech, under just this head of variations of quality. The question arises, therefore, Have the principles just developed any claim to validity in the explanation of *qualitative* modifications?

In considering this question it should be carefully borne in mind that by far the largest part of the qualitative modifications falling under this head rest on *quantitative* changes. Of course, chemical transformations, which usually also involve quantitative alterations, cannot be reduced to the processes of augmentation described, inasmuch as these, by their very nature, can be effected only in living elements capable of increase by propagation; but the interference of selection does not begin originally with the "constitutional elements" (the *Anlagen*) of the germ, i. e. with the determinants, but with the ultimate units of life, the *biophores*.

A determinant must be composed of heterogeneous biophores, and on their numerical proportion reposes, according to our hypothesis, their specific nature. If that proportion is altered, so also is the character of the determinant. But disturbances of this numerical proportion must result at once on their usefulness being proved, or as soon as the modifications determined thereby in the inward character of the determinant prove to be of utility. For fluctuations of nutriment and the struggle for nutriment, with its sequent preference of the strongest, must take place between the various species of the biophores as well as between the species of the determinants. But changes in the quantitative ratios of the biophores appear to us qualitative changes in the corresponding determinants, somewhat as a simple augmentation of a determinant, for example, that of a hair, may, on its development appear to us as a qualitative change, a spot on the skin where previously only isolated hairs stood being now densely crowded with them, and assuming thus the character of a downy piece of fur. The single hair need not have changed in this process, and yet the spot has virtually undergone a qualitative modification. The majority of the

changes that appear to us qualitative rest on invisible *quantitative* changes, and such can be produced at all times and *at all stages of the vital units* by germinal selection. In a similar manner are induced the most varied qualitative changes of the corresponding determinants and of the characters conditioned thereby, just as changes in the numerical proportions of atoms produce essential changes in the properties of a chemical molecule.

In this way we acquire an approximate conception of the possible mechanical *modus operandi* of actual events—namely, of the manner in which the useful variations required by the conditions of life *can* always, that is, very frequently, make their appearance. This possibility is the sole condition of our being able to understand how different parts of the body, absolutely undefined in extent, can appear as variational units and vary in the same or in different directions, according to the special needs of the case, or as the conditions of life prescribe. Thus, for example, in the case of the butterfly's wings it rests entirely with utility to decide the size and the shape of the spots that shall vary simultaneously in the same direction. At one time the whole under surface of the wing appears as the variational unit and has the same color; at another the inside half, which is dark, is contrasted with the outside half which is bright; or the same contrast will exist between the anterior and posterior halves; or, finally, narrow stripes or line-shaped streaks will behave as variational units and form contrasts with manifold kinds of spots or with the broader intervals between them, with the result that the picture of a leaf or of another protected species is produced.

I must refrain from entering into the details of such cases and shall illustrate my views regarding the color-transformations of butterflies' wings by the simplest conceivable example—viz. that of the uniform change of color on the entire under surface of the wing.

Let us suppose, for example, that the ancestral species of a certain forest-butterfly habitually reposed on branches near the ground and covered with dry or rotten leaves; such a species will have assumed on its under surface a protective coloring which by its dark, brown, yellow, or red tints will tend towards a similarity with such leaves. If, however, the descendants of this species

should be subsequently compelled, no matter from what cause, to adopt the habit of resting higher up, on the green-leafed branches, then from that period on the brown coloring would act less protectively than the shades verging towards green. And a process of selection will have set in which consisted first in giving preference only to such persons whose brown and yellow tints showed a tendency to green. Only on the assumption that such shades were possible by a displacement in the quantitative proportions of the different kinds of biophores composing the determinants of the scales affected, was a further development in the direction of green possible. Such being the case, however, that development *had to* result; because fluctuations in the numerical proportions of the biophores are always taking place, and consequently the material for germinal selection is always at hand. At present it is impossible to determine exactly the magnitude of the initial stages of the deviations thus brought about and promoted by the sexual blending of characters; but it may perhaps be ascertained in the future, with exceptionally favorable material. Pending such special observations, however, it can only be said *a priori* that slight changes in the composition of a determinant do not necessarily condition similar slight deviations of the corresponding character,—in this case the color,—just as slight changes in the atomic composition of a molecule may result in bestowing upon the latter widely different properties. As soon, however, as the beginning has been made and a definite direction has been imparted to the variation, as the result of this or that primary variation being preferred, the selective process must continue until the highest degree of faithfulness required by the species in the imitation of fresh leaves has been attained.

That the foregoing process has actually taken place is evidenced not only by the presence of the beginnings of such transformations, as found for example in some greenish-tinted specimens of Kallima, but mainly by certain species of the South American genus Catonephele, all of which are forest-butterflies, and which, with many species having dark-brown under surfaces, present some also with bright green under surfaces—a green that is not like the fresh green

of our beech and oak trees, but resembles the bright under surface of the cherry-laurel leaf, and is the color of the under surfaces of the thick, leathery leaves, colored dark-green above, borne by many trees in the tropics.

The difference between this and the old conception of the selection-process consists not only in the fact that a large number of individuals with the initial stages of the desired variation is present from the beginning, for always innumerable plus and minus variations exist, but principally in the circumstance that the constant uninterrupted progress of the process after it is once begun is assured, that there can never be a lack of progressively advantageous variations in a large number of individuals. Selection, therefore, is now not compelled to wait for accidental variations but produces such itself, whenever the required elements for the purpose are present. Now, where it is a question simply of the enlargement or diminution of a part, or of a part of a part, these variations are always present, and in modifications of quality they are at least present in many cases.

This is the only way in which I can see a possibility of explaining phenomena of *mimicry*—the imitation of one species by another. The useful variations must be produced in the germ itself by internal selection-processes if this class of facts is to be rendered intelligible. I refer to the mimicry of an exempt species by two or three other species, or, the aping of *different* exempt patterns by *one* species in need of protection. It must be conceded to Darwin and Wallace that some degree of similarity between the copy and the imitation was present from the start, at least in very many cases;[1] but in no case would this have been sufficient had not slight shades of coloring afforded some hold for personal selection, and in this way furnished a basis for independent germinal selection acting

[1] That this is not so in all cases has recently been shown by Dixey from observations on certain white butterflies of South America which mimic the Heliconids and in which a small, yellowish red streak on the under surface of the hind wing has served as the point of departure and groundwork of the development of a protective resemblance to quite differently colored Heliconids. "On the Relation of Mimetic Characters to the Original Form," in the *Report of the British Association for 1894*.

only in the direction indicated. It would have been impossible for such a minute similarity in the design, and particularly in the shades of the coloration, ever to have arisen, if the process of adaptation rested entirely on personal selection. Were this so, a complete scale of the most varied shades of color must have been continually presented as variations in every species, which certainly is not the case. For example, when the exempt species *Acræa Egina*, whose coloration is a brick-red, a color common only in the genus Acræa, is mimicked by two other butterflies, a Papilio and a Pseudacræa, so deceptively that not only the cut of the wings and the pattern of their markings, but also that precise shade of brick-red, which is scarcely ever met with in diurnal butterflies, are produced, assuredly such a result cannot rest on accidental, but must be the outcome of a *definitely directed*, variation, produced by utility. We cannot assume that such a coloration has appeared as an *accidental* variation in just and in only these two species, which fly together with the *Acræa* in the same localities of the same country and same part of the world—the Gold Coast of Africa. It is conceivable, indeed, that non-directed variation should have accidentally produced this brick-red *in a single case*, but that it should have done so three times and in three species, which live together but are otherwise not related, is a far more violent and improbable assumption than that of a causal connexion of this coincidence. Now hundreds of cases of such mimicry exist in which the color-tints of the copy are met with again in more or less precise and sometimes in exceedingly exact imitations, and there are thousands of cases in which the color-tint of a bark, of a definite leaf, of a definite blossom, is repeated *exactly* in the protectively colored insect. In such cases there can be no question of accident, but *the variations presented to personal selection must themselves have been produced by the principle of the survival of the fit!* And this is effected, as I am inclined to believe, through such profound processes of selection in the interior of the germ-plasm as I have endeavored to sketch to you to-day under the title of germinal selection.

I am perfectly well aware how schematic my presentation of this process is, and must be at present, owing mainly to our inabil-

ity to gain exact knowledge concerning the fundamental germinal constituents here assumed. But I regard its existence as assured, although I by no means underrate the fact that eminent thinkers, like Herbert Spencer, contest its validity and believe they are warranted in assuming a germ which is composed of *similar units*. I strongly doubt whether even so much as a *formal* explanation of the phenomena can be arrived at in this manner. So far as direct observation is concerned, the two theories stand on an equal footing, for neither my dissimilar, nor Spencer's similar, units of germinal substance can be *seen* directly.

The attempt has been recently made to discredit my *Anlagen*, or constitutional germ-elements, on the ground that they are simply a subtilised reproduction of Bonnet's old theory of preformation.[1] This impression is very likely based upon ignorance of the real character of Bonnet's theory. I will not go into further details here, particularly as Whitman, in several excellently written and

[1] Oscar Hertwig, *Zeit- und Streitfragen der Biologie*, Jena, 1894. It is customary now to look upon the preformation-theory of Bonnet as a discarded monstrosity, and on the epigenesis of K. F. Wolff as the only legitimate view, and to draw a parallel between these two and what might be called to-day "evolution" [i. e. unfoldment] and epigenesis. The evolution, or unfoldment, of Bonnet and Harvey, however, was something totally different from modern doctrines of evolution, and Whitman is quite right when he says that even my theory of determinants would have appeared to the inquirers of the last century as "extravagant epigenesis." Biologists in that day were concerned with quite different questions from what they are at present, and although now we probably all share the conviction of Wolff that new characters do arise in the course of evolution, yet the acceptance of this view is far from settling the question *as to how these new characters are established in the germ-substance*—for in this substance they certainly must have their foundation. When, therefore, O. Hertwig laments over my regarding evolution and not epigenesis as the correct foundation of the theory of development, his sorrow is almost as naïve as is the statement of Bourne that epigenesis is a fact and not a theory ("a statement of morphological fact," *Science Progress*, April, 1894, page 108), or, as is the latter's unconsciousness that facts originally receive their scientific significance from thought, i. e. from their interpretation and combination, and that thought *is* theory. And when S. Minot, as the leader of the embryologists, carries his zeal to the pitch of issuing a general pronunciamento against me as a seducer of the youth, in which he declares it to be a "scientific duty to protest in the most positive manner against Weismann's theory," I wonder greatly that he does not suggest the casting of a general ballot in the matter. (See the *Biologisches Centralblatt* of August 1, 1895.) We see how with these gentlemen the wisdom of the recitation-room regarding the infallibility of epigenesis has grown into a dogma, and whoever ventures to disturb its foundations must be burnt as a heretic.

finely conceived essays, has recently afforded opportunity for every one to inform himself on the subject. My determinants and groups of determinants have nothing to do with the preformations of Bonnet; in a sense they are the exact opposites of them; they are simply *those living parts of the germ whose presence determines the appearance of a definite organ of a definite character in the course of normal evolution.* In this form they appear to me to be an absolutely necessary and unavoidable inference from the facts. There *must* be contained in the germ parts that correspond to definite parts of the complete organism, that is, parts that constitute the reason why such other parts are formed.

It is conceded even by my opponents that the reason why one egg produces a chicken and another a duck is not to be sought in external conditions, but lies in a difference of the germinal substance. Nor can they deny that a difference of germinal substance must also constitute the reason why a slight *hereditary* difference should exist between two filial organisms. Should there now, in a possible instance, be present between them a second, a third, a fourth, or a hundredth difference of hereditary character, each of which could vary from the germ, then, certainly, some second, third, fourth, or hundredth part of the germ must have been different; for whence, otherwise, should the heredity of the differences be derived, seeing that external influences affecting the organism in the course of evolution induce only non-transmissible and transient deviations? But the fact that every complex organism is actually composed of a very large number of parts independently alterable from the germ, follows not only from the comparison of allied species, but also and principally from the experiments long conducted by man in artificial selection, and by the consequent and not infrequent change of only a single part which happens to claim his interest, for example, the tail-feathers of the cock, the fruit of the gooseberry, the color of a single feather or group of feathers, and so on. But a still more cogent proof is furnished by the degeneration of parts grown useless, for this process can be carried on to almost any extent without the rest of the body necessarily becoming involved in sympathetic alteration. Whole members may become rudimentary, like the hind limbs

of the whale, or it may be only single toes or parts of toes; the whole wing may degenerate in the females of a butterfly species, or only a small circular group of wing-scales, in the place of which a so-called "window" arises. A single vein of the wing also can degenerate and disappear, or the process may affect only a part of it, and this may happen in one sex only of a species. In such cases the rest of the body may remain absolutely unaltered; only a stone is taken out of the mosaic.

The assumption, thus, appears to me irresistible, that every such hereditary and likewise independent and very slight change of the body rests on some alteration of *a single* definite particle of the germinal substance, and not as Spencer and his followers would have it, on a change of *all* the units of the germ. If the germinal substance consisted wholly of like units, then in every change, were it only of a single character, *each* of these units would have to undergo exactly the same modification. Now I do not see how this is possible.

But it may be that Spencer's assumption is the *simpler* one? Quite the contrary, its simplicity is merely apparent. Whilst my theory needs for each modification only a modification of *one* constitutional element of the germ, that is, of *one* particle of the germinal substance, according to Spencer *every* particle of that substance must change, for they are all supposed to be and to remain alike. But seeing that all hereditary differences, be they of individuals, races, or species, must be contained in the germ, the obligation rests on these similar units, or rather the capacity is required of them, to produce in themselves a truly enormous number of differences. But this is possible only provided their composition is an exceedingly complex one, or only on the condition that in every one of them are contained as many alterable particles as according to my view there are contained determinants in the whole germ. *The differences that I put into the whole germ, Spencer and his followers are obliged to put into every single unit of the germinal substance.* My position on this point appears to me incontrovertible so long as it is certain that the *single* characters can vary hereditarily; for, if a thing can vary independently, that is, *of its own accord*, and *from the germ*,

then that thing must be represented in the germ by some particle of the substance, *and be represented there in such wise that a change of the representative particle produces no other change in the organism developing from the germ than such as are connected with the part which depends on it.* I conceive that even on the assumption of constitutional elements the germ-plasm is complex enough, and that there is no need of increasing its complexity to a fabulous extent. Be that as it may, the person who fancies he can produce a complex organism from a *really* simple germinal substance is mistaken: he has not yet thoroughly pondered the problem. The so-called "epigenetic" theory with its *similar* germinal units is therefore naught else than an evolution-theory where the primary constitutional elements are set back into the molecules and atoms—a view which in my judgment is inadmissible. A *real* epigenesis from absolutely *homogeneous* and not merely *like* units is not thinkable.

All value has been denied my doctrine of determinants[1] on the ground that it only shifts the riddles of evolution to an invisible terrain where it is impossible for research to gain a foothold.

Now I have indeed to admit that no information can be gained concerning my determinants, either with the aided or with the unaided eye. But fortunately there exists in man another organ which may be of use in fathoming the riddles of nature and this organ which is called the brain has in times past often borne him out in the assumption of invisible entities—entities that have not always proved unfruitful for science by reason of that defect, in proof whereof we may instance the familiar assumptions of atoms and molecules. Probably the biophores also will be included under that head if the determinants should be adjudged utterly unproductive. But so far I have always held that assumptions of this kind *are* really productive if they are only capable of being used, so to speak, as a *formula*, whereby to perform our computations, unconcerned for the time being as to what shall be its subsequent fate. Now, as I take it, the determinants have had fruitful results, as their application to various biological problems shows. Is it no advance that we are able to re-

[1] Oscar Hertwig, *Zeit- und Streitfragen der Biologie*, Jena, 1894.

duce the scission of a form of life into two or several forms subject to separately continued but recurrent changes,—I refer to dimorphism and polymorphism,—that we are able to reduce such phenomena to the formula of male, female, and worker determinants? It has been, I think, rendered conceivable how these diverse and extremely minute adaptations could have developed side by side in the same germ-plasm, under the guidance of selection; how sterile forms could be *hereditarily* established and transformed in just that manner which best suits with their special duties; and how they themselves under the right circumstances could subsequently split up into two or even into three new forms. Surely at least the unclear conception of an *adaptively* transformative influence of food must be discarded. It is true, we cannot penetrate by this hypothesis to the last root of the phenomena. The hotspurs of biology, who clamor to know forthwith how the molecules behave, will scarcely repress their dissatisfaction[1] with such provisional knowledge—forgetful that *all our knowledge is and remains throughout provisional.*

But I shall not enter more minutely into the question whether epigenesis or evolution is the right foundation of the theory of development, but shall content myself with having shown, first, that it is illusory to imagine that epigenesis admits of a simpler structure of the germ, (the precise opposite is true,) and secondly, that there are phenomena that can be understood only by an evolution-theory. Such a phenomenon is the *guidance of variation by utility*, which we have considered to-day. For without primary constituents of the germ, whether they are called as I call them, determinants, or something else, *germinal selection*, or guidance of variation by personal selection, is impossible; for where all units are alike there can be

[1]Nor will those, who demand a demonstration of "how the biophores and determinants are constituted in every case, and must be arranged in the architecture of the germ-plasm." (O. Hertwig, *loc. cit.*, p. 137). As if any living being could have the temerity to pretend even so much as to guess at the *actual* ultimate phenomena in evolution and heredity! The whole question is a matter of symbols only, just as it is in the matter of "forces," "atoms," "ether undulations," etc., the only difference being that in biology we stumble much earlier upon the unknown than in physics.

no struggle, no preference of the best. And yet such a guidance of variation exists and demands its explanation, and the early assumptions of a "definitely directed variation" such as Nägeli and Askenasy made are insufficient, for the reason that they posit only *internal* forces as the foundations thereof, and because, as I have attempted to show, the harmony of the direction of variation with the requirements of the conditions of life subsists and represents the riddle to be solved. *The degree of adaptiveness which a part possesses, itself evokes the direction of variation of that part.*

This proposition seems to me to round off the whole theory of selection and to give to it that degree of inner perfection and completeness which is necessary to protect it against the many doubts which have gathered around it on all sides like so many lowering thunder-clouds. The moment variation is determined substantially though not exclusively by the adaptiveness itself, all these doubts fall to the ground, with *one* exception, that of the utility of the initial steps. But just this objection is the least weighty. Without doubt the theory requires that the initial steps of a variation should also have selective value; otherwise personal selection and hence germinal selection could not set in. Since, however, as I have before pointed out, *in no case can we pretend to a judgment regarding the selective value of a modification, or have any experience thereof*, therefore the assumption that in a given case where a character is transformed the original initial steps of the variation did have selective value, is not only as probable as the opposed assumption that they had none, but is *infinitely more probable*, for with this we can give an intelligible explanation of the mysterious fact of adaptation, while with that we cannot. Consequently, unless we are resolved to give up all attempts whatsoever at explanation, we are forced to the assumption that the initial steps of all actually effected adaptations possessed selective value.

The principal and fundamental objection that selection is unable to create the variations with which it works, is removed by the apprehension that a germinal selection exists. Natural selection is not compelled to wait until "chance" presents the favorable variations, but supposing merely that the groundwork for favorable variations is

present in the transforming species, that is, supposing merely that in the constitutional basis of the part to be changed are contained components which render favorable variations possible by a change of their numerical ratio, then those variations *must* occur, for the reason that quantitative fluctuations are always happening, and they must also be augmented as soon as personal selection intervenes and permanently holds over them her protecting hand. Not only is the marvellous *certainty and exactitude* with which adaptation has operated in so many individual cases, rendered intelligible in this manner, but what is more difficult, we are able to understand the *simultaneity* of numerous and totally different modifications of the most diverse parts co-operant towards some collective end, such as we see so frequently occur, for example, in the simultaneous rise of instincts and protective similarities, or, in the harmonious and simultaneous augmentation of two co-operant but independent organs, as of the eye and of the centre of vision, or of the nerve and its muscle, etc.

The "secret law," of which Wolff prophetically speaks in his criticism of selection, is in all likelihood naught else than germinal selection. This it is that brings it about that the necessary variations are always present, that symmetrical parts, for example, the two eyes, usually vary alike, but under circumstances may vary differently, for example, the two visual halves of soles; that homodynamic parts, (for instance, the member-pairs of Arthropoda,) have frequently varied alike, and not infrequently and in conformity with the needs of the animal, have varied differently. It brings it about also that conversely species of quite different fundamental constitutions occasionally vary alike, as instances of mimicry and numerous other cases of convergence show us. As soon as utility itself is supposed to exercise a determinative influence on the direction of variation, we get an insight into the entire process and into much else besides that has hitherto been regarded as a stumbling-block to the theory of selection, and which did indeed present difficulties which for the moment were insuperable—as, for example, the like-directed variation of a large number of already existing similar parts, seen in the origin of feathers from the scales of reptiles. The

utility in the last-mentioned instance consisted, not in the transformation of one or of two, but of *all* the scales; consequently the line of variation of *all* the scales must have been started simultaneously in the same direction. A large part of the objections to the theory of selection that have been recently brought forward by the acutest critics, as for example by Wigand, but particularly by Wolff,[1] find, as I believe, their refutation in this doctrine of germinal selection. The principle extends precisely as far as utility extends, inasmuch as it creates, not only the direction of variation for every increase or diminution demanded by the circumstances, but also every qualitative direction of variation attainable by changes of quantity, so far as that is at all possible for the organism in question.

Considering also the contrary process, the degeneration of useless parts by the cessation of selection in regard to the normal size of that part, a clear light is shed on that whole complex system of ascending and descending modifications which makes up most of the transformations of a living form, and we are led to understand how the *fore* extremity of a mammal can change into a fin at the same time that the *hinder* extremity is growing rudimentary, or how one or two toes of a hoofed animal can continue to develop more and more powerfully, whilst the others in the same degree grow weaker and weaker until finally they have disappeared entirely from the germ of most of the individuals of the species.

Possibly some of that large body of inquirers, mostly paleontologists, who till now have considered the Lamarckian principle indispensable for the explanation of these phenomena—perhaps some, I say, will not utterly close their eyes to the insight that germinal selection performs the same services for the understanding of observed transformations, particularly of the degeneration of superfluous parts, that a heredity of acquired characters would perform, without rendering necessary so violent an assumption. I have always conceded that many transformations actually do run parallel

[1] "Beiträge zur Kritik der Darwin'schen Lehre," *Biologisches Centralblatt*, Vol. X., p. 449. 1890.

to the use and disuse of the parts,[1] that therefore it does really look as if functional acquisitions of the individual life were hereditary. But if it be found that *passively functioning parts*, that is, parts which are not alterable during the individual life by function, obey the same laws and also degenerate when they become useless, then we shall scarcely be able to refuse our assent to a view which explains both cases. It certainly cannot be the physiological function which provokes modifications in the individual, which are then subsequently transmitted to the germ and in this way made hereditary, *if functionless parts also change* when they become useless. It is precisely this *uselessness*, then, from which the initial impulse emanates, and the primary modification is not in the soma but in the germ.

The Lamarckians were right when they maintained that the factor for which hitherto the name of natural selection had been exclusively reserved, viz., *personal* selection, was insufficient for the explanation of the phenomena. They were also right when they declared that panmixia in the form in which until recently I held the theory was also insufficient to explain the degeneration of parts that had grown useless, but they erred when they ascribed hereditary effects to the selection-processes which are enacted among the parts of the body (Wilhelm Roux) and which are rightly regarded as the results of functioning. And they did this, moreover, as they themselves admit, not because the facts of heredity directly and unmistakably required it, but because they saw no other possibility of explaining many phenomena of transformation. I am fain to relinquish myself to the hope that now after another explanation has been found, a reconciliation and unification of the hostile views is not so very distant, and that then, we can continue our work together on the newly laid foundations.

That the application of the Malthusian principle was thoroughly justified is now clear. *The entire process of the development of living*

[1] Poulton has adverted to the fact that this is nevertheless not always the case; for example, it is not so with the teeth, whose shape it had also been sought to reduce to the mechanical effects of pressure and friction. See "The Theory of Selection" in *The Proceedings of the Boston Society of Natural History*, Vol. XX., page 389. 1894.

forms is guided by this principle. The struggle for existence, *videlicet*, for food and propagation, takes place at all the stages of life between all orders of living units from the biophores recently disclosed upwards to the elements that are accessible to direct observation, to the cells, and still higher up, to individuals and colonies. Consequently, in all the divers orders of biological units lying between the two extremes of biophores and colonies, the modifications must be controlled by selective processes; therefore, these govern every change of living forms no matter what its significance, and bring it about that the latter fit their conditions of life as wax does the mould; and the various stages of these processes, as enacted between the divers orders of biological units, in all organisms not absolutely simple, are involved in incessant and mutual interaction. The three principal stages of selection, that of *personal* selection[1] as it was enunciated by Darwin and Wallace, that of *histonal* selection as it was established by Wilhelm Roux in the form of a "struggle of the parts," and finally that of *germinal selection* whose existence and efficacy I have endeavored to substantiate in this article—these are the factors that have co-operated to maintain the forms of life in a constant state of viability and to adapt them to their conditions of life, now modifying them *pari passu* with their environment, and now maintaining them on the stage attained, when that environment is not altered.

Everything is adapted in animate nature[2] and has been from

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[1] As the highest stage of selective processes must be regarded that between the highest biological units, the colonies or cormi—a stage, however, which is not essentially different from personal selection. In this stage the persons enact the part that the organs play in personal selection. Like their prototypes they also battle with one another for food and in this way maintain harmony in the colony. But the result of the struggle endures only during the life of the individual colony and can be transmitted through the germ-cells to the following generation as little as can histological changes provoked by use in the individual person. Only that which issues from the germ has duration.

[2] This statement has often been declared extravagant, and it is so if it is taken in its strict literalness. On the other hand, it would also seem, by a more liberal interpretation, as if there existed non-adaptive characters, for example, rudimentary organs. Adaptiveness, however, is never absolute but always conditioned, that is, is never greater than outward and inward circumstances permit. Moreover, an organ can only disappear gradually and slowly when it has become superfluous;

the first beginnings of life; for adaptiveness of organisation is here equivalent to the power to exist, and they alone have had the power to exist who have permanently existed. *We know of only one natural principle of explanation for this fact—that of selection, of the picking out of those having the power to exist from those having the power to originate.* If there is any solution possible to the riddle of adaptiveness to ends,—a riddle held by former generations to be insoluble,—it can be obtained only through the assistance of this principle of the self-regulation of the originating organisms, and we should not turn our faces and flee at the sight of the first difficulties that meet its application, but should look to it whether the apparent effects of this single principle of explanation are not founded in the imperfect application that is made of it.

If I am not mistaken the situation is as follows. We had remained standing half way. We had applied the principle, but only to a portion of the natural units engaged in struggle. If we apply the principle throughout we reach a satisfactory explanation. Selection of *persons* alone is *not sufficient* to explain the phenomena; *germinal* selection must be added. Germinal selection is the last consequence of the application of the principle of Malthus to living nature. It is true it leads us into a terrain which cannot be submitted directly to observation by means of our organs of touch and by our eyes, but it shares this disadvantage in common with all other ultimate inferences in natural science, even in the domain of inorganic nature: in the end all of them lead us into hypothetical regions. If we are not disposed to follow here nothing remains but to abandon utterly the hope of explaining the adaptive character of life—a renunciation which is not likely to gain our approval when we reflect that by the other method is actually offered at least in principle, not only a broad insight into the adaptation of the single forms of life to their conditions, but also into the mode of formation

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yet this does not prevent our recognising every stage of its degeneration as adapted when compared with its precursor. Further, it does not militate against the correctness of the above proposition that there are also characters whose fitness consists in their being the necessary accompaniments of other directly adapted features, as, for instance, the red color of the blood.

of the living world as a whole. The variety of the organised world, its transformation by adaptation to new, and by reversed adaptation to old conditions, the inequality of the systematic groups, the attainment of the same ends by different means, that is, by different organisations, and a thousand and one other things assume on this hypothesis in a certain measure an intelligible form, whilst without it they remain lifeless facts.

And so in this case, I may say, that again doubt is the parent of all progress. For the idea of germinal selection has its roots in the necessity of putting something else in the place of the Lamarckian principle, after that had been recognised as inadequate. That principle did, indeed, seem to offer an easy explanation of many phenomena, but others stood in open contradiction to it, and consequently that was the point at which the lever had to be applied if we were to penetrate deeper into the phenomena in question. For it is at the places where previous views are at variance with facts that the divining rod of the well-seekers must thrice nod. There lie the hidden waters of knowledge, and they will leap forth as from an artesian well if he who bores will only drive undaunted his drill into their depths.

AUGUST WEISMANN.

FREIBURG i. B.

ON THE NATURE OF MATHEMATICAL KNOWLEDGE.

"MATHEMATICALLY certain and indubitable" is a phrase which is often heard in the sciences and in common life, to express the idea that the seal of truth is more deeply imprinted upon a proposition than is the case with ordinary acts of knowledge. We propose to investigate here to what extent mathematical knowledge really is more certain and unequivocal than other knowledge.

The intrinsic character of mathematical research and knowledge is based essentially on three properties: first, on its conservative attitude towards the old truths and discoveries of mathematics; secondly, on its progressive mode of development, due to the incessant acquisition of new knowledge on the basis of old knowledge; and thirdly, on its self-sufficiency and its consequent absolute independence.

That mathematics is the most conservative of all the sciences is apparent from the incontestability of its propositions. This last character bestows on mathematics the enviable superiority that no new development can undo the work of previous developments or substitute new in the place of old results. The discoveries that Pythagoras, Archimedes, and Apollonius made are as valid to-day as they were two thousand years ago. This is a trait which no other science possesses. The notions of previous centuries regarding the nature of heat have been disproved. Goethe's theory of colors is now antiquated. The theory of the binary combination of salts was supplanted by the theory of substitution, and this, in its turn, has also given way to newer conceptions. Think of the pro-

found changes which the conceptions of theoretical medicine, zoölogy, botany, mineralogy, and geology have undergone. It is the same, too, in the other sciences. In philology, comparative linguistics, and history our ideas are quite different from what they formerly were.

In no other science is it so indispensable a condition that whatever is asserted must be true, as it is in mathematics. Whenever, therefore, a controversy arises in mathematics, the issue is not whether a thing is true or not, but whether the proof might not be conducted more simply in some other way, or whether the proposition demonstrated is sufficiently important for the advancement of the science as to deserve especial enunciation and emphasis, or finally, whether the proposition is not a special case of some other and more general truth which is just as easily discovered.

Let me recall the controversy which has been waged in this century regarding the eleventh axiom of Euclid, that only one line can be drawn through a point parallel to another straight line. This discussion impugned in no wise the truth of the proposition; for that things are true in mathematics is so much a matter of course that on this point it is impossible for a controversy to arise. The discussion merely touched the question whether the axiom was capable of demonstration solely by means of the other propositions, or whether it was not a special property, apprehensible only by sense-experience, of that space of three dimensions in which the organic world has been produced and which therefore is of all others alone within the reach of our powers of representation. The truth of the last supposition affects in no respect the correctness of the axiom but simply assigns to it, in an epistemological regard, a different status from what it would have if it were demonstrable, as was one time thought, without the aid of the senses, and solely by the other propositions of mathematics.

I may recall also a second controversy which arose a few decades ago as to whether all continuous functions were differentiable. In the outcome, continuous functions were defined that possessed no differential coefficient, and it was thus learned that certain truths which were enunciated unconditionally by Newton, Leibnitz, and

their mathematical successors, required qualification. But this did not invalidate at all the correctness of the method of differentiation and its application in all practical cases; the theoretical speculations pursued on this subject simply clarified ideas and sifted out the conditions upon which differentiability depended. Happily the gifted minds who create the new methods and open up the new paths of research in mathematics, are not deterred by the fear that a subsequent generation gifted with unusual acumen will spy out isolated cases in which their methods fail. Happily the creators of the differential calculus pushed onward without a thought that a critical posterity would discover exceptions to their results. In every great advance that mathematics makes, the clarification and scrutinisation of the results reached are reserved necessarily for a subsequent time, but with it the demonstration of those results is more rigorously established. Despite all this, however, in no science does cognition bear so unmistakably the imprint of truth as in pure mathematics. And this fact bestows on mathematics its conservative character.

This conservative character again is displayed in the *objects* of mathematical research. The physician, the historian, the geographer, and the philologist have to-day quite different fields of investigation from what they had centuries ago. In mathematics, too, every new age gives birth to new problems, arising partly from the advance of the science itself, and partly also from the advance of civilisation, where improvements in the other sciences bring in their train the formulation of problems that are constantly taxing anew the resources of mathematics. But despite all this, in mathematics more than in any other science problems exist that have played a rôle for hundreds, nay, for thousands of years.

In the oldest mathematical manuscript which we possess, the Papyrus Rhind of the British Museum, which dates back to the eighteenth century before Christ, and whose decipherment we owe to the industry of Eisenlohr, we find an attempt to solve the problem of converting a circle into a square of equal area, a problem whose history covers a period of three and a half thousand years. For it was not until 1882 that a rigorous proof was given of the im-

possibility of solving this problem exactly by the use of compasses and ruler alone.

It is, of course, the insoluble problems that have the longest history; partly because it is harder to show that a thing is impossible than that it is possible, and, on the other hand, because problems that have long defied solution are ever evoking anew the spirit of inquiry and the ambition of mathematicians, and because the uncertainty of insolubility lends to such problems a peculiar charm. Of the geometrical problems that have occupied competent and incompetent minds from the time of the ancient Greeks to the present may be mentioned in addition to the squaring of the circle two others that are also perhaps well-known to educated readers, at least by name: the trisection of the angle and the Delic problem of the duplication of the cube. All three problems involve the condition, which is often overlooked by unprofessional readers, that only compasses and ruler shall be employed in the constructions. In the trisection of the angle any angle is assigned, and it is required to find the two straight lines which divide the angle into three equal parts. In the Delic problem the edge of a cube is given and the edge of a second cube is sought, containing twice the volume of the first cube. In Greece, in the golden age of the sciences, when all scholars had to understand mathematics, it was a fashionable requisite almost, to have employed oneself on these famous problems.

Fortunately for us, these problems were insoluble. For in their ambition to conquer them it came to pass that men busied themselves more and more with geometry, and in this way kept constantly discovering new truths and developing new theories, all of which perhaps might never have been done if the problems had been soluble and had early received their solutions. Thus is the struggle after truth often more fruitful than the actual discovery of truth. So, too, although in a slightly different sense, the apophthegm of Lessing is confirmed here, that the search for truth is to be preferred to its possession.

Whilst the three above-named problems are now acknowledged to be insoluble, and have ceased, therefore, to stimulate mathematical inquiry, there are of course other problems in mathematics

whose solution has been sought for a long time, but not yet reached, and in the case of which there is no reason for supposing that they are insoluble. Of such problems the two following perhaps have found their way out of the isolated circles of mathematicians and have become more or less known to other scholars. I refer to the astronomical Problem of Three Bodies and to the problem of the frequency of prime numbers. The first of these two problems assumes three or more heavenly bodies whose movements are mutually influenced by one another according to Newton's law of gravitation, and requires the exact determination of the path which each body describes. The second problem requires the construction of a formula which shall tell how many prime numbers there are below a certain given number. So far these two problems have been solved only approximately, and not with absolute mathematical exactness.

If the eternal and inviolable correctness of its truths lends to mathematical research, and therefore also to mathematical knowledge, a *conservative* character, on the other hand, by the continuous outgrowth of new truths and methods from the old, *progressiveness* is also one of its characteristics. In marvellous profusion old knowledge is augmented by new, which has the old as its necessary condition, and, therefore, could not have arisen had not the old preceded it. The indestructibility of the edifice of mathematics renders it possible that the work can be carried to ever loftier and loftier heights without fear that the highest stories shall be less solid and safe than the foundations, which are the axioms, or the lower stories, which are the elementary propositions. But it is necessary for this that all the stones should be *properly fitted together*; and it would be idle labor to attempt to lay a stone that belonged above in a place below. A good example of a stone of this character belonging in what is now the uppermost layer of the edifice, is Lindemann's demonstration of the insolubility of the quadrature of the circle, a demonstration of which interesting simplifications have been given by several mathematicians, including Weierstrass and Felix Klein. Lindemann's demonstration could not have been produced in the preceding century, because it rests necessarily on theories whose development falls in the present century. It is true,

Lambert succeeded in 1761 in demonstrating the irrationality of the ratio of the circumference of a circle to its diameter, or, which is the same thing, the irrationality of the ratio of the area of a circle to the area of the square on its radius. Afterwards, Lambert also supplied a proof that it was impossible for this ratio to be the square root of a rational number. But this was the first step only in a long journey. The attempt to prove that the old problem is insoluble was still destined to fail. An astounding mass of mathematical investigations were necessary before the demonstration could be successfully accomplished.

As we see, the majority of the mathematical truths now possessed by us presuppose the intellectual toil of many centuries. A mathematician, therefore, who wishes to-day to acquire a thorough understanding of modern research in this department, must think over again in quickened tempo the mathematical labor of several centuries. This constant dependence of new results on old ones stamps mathematics as a science of uncommon exclusiveness and renders it mostly impossible to open up to uninitiated readers a speedy path to the apprehension of the higher mathematical truths. For this reason, too, the theories and results of mathematics are rarely adapted for popular presentation. There is no royal road to the knowledge of mathematics, as Euclid once said to the first Egyptian Ptolemy. This same inaccessibility of mathematics, although it secures for it a lofty and aristocratic place among the sciences, also renders it odious to those who have never learned it, and who dread the great labor involved in acquiring an understanding of the questions of modern mathematics. Neither in the languages nor in the natural sciences are the investigations and results so closely interdependent as to make it impossible to acquaint the uninitiated student with single branches or with particular results of these sciences, without causing him to go through a long course of preliminary study.

The third trait which distinguishes mathematical research is its self-sufficiency. In philology the field of inquiry is the organic one of languages, and philology, therefore, is dependent in its investigations on the mode of development of languages, which is more or

less accidental. Its task is connected with something which is given to it from without and which it cannot alter. It is much the same with the science of history, which must contemplate the history of mankind as it has actually occurred. Also zoölogy, botany, mineralogy, geology, and chemistry work with given data. In order not to become involved in futile speculations the last-mentioned sciences are constantly and inevitably obliged to revert to observations by the senses. It is then their task to link together these individual observations by bonds of causality and in this way to erect from the single stones an edifice, the view of which will render it easier for limited human intelligence to comprehend nature. Physics of all sciences stands nearest to mathematics in this respect, because unlike the other sciences she is generally in need of only a few observations in order to proceed deductively. But physics, too, must resort to observations of nature, and could not do without them for any length of time.

Mathematics alone, after certain premises have been permanently established, is able to pursue its course of development independently and unmindful of things outside of it. It can leave entirely unnoticed, questions and influences emanating from the outer world, and continue nevertheless its development.

As regards geometry, the first beginnings of this science did indeed take their origin in the requirements of practical life. But it was not long before it freed itself from the restrictions of the practical art to which it owed its birth. Herodotus recounts that geometry had its origin in Egypt where the inundations of the Nile obliterated the boundaries of the riparian estates, and by giving rise to frequent disputes constantly compelled the inhabitants to compare the areas of fields of different shapes. But with the early Greek mathematicians, who were the heirs of the Egyptian art of measurement, geometry appeared as a science which men pursued for its own sake without a thought of how their intellectual discoveries could be turned to practical account.

Nevertheless, although the workers in the domain of pure mathematics are not stimulated by the thought that their researches are likely to be of practical value, yet that result is still frequently real-

ised, often after the lapse of centuries. The history of mathematics shows numerous instances of mathematical results which were originally the outcome of a mere desire to extend the science, suddenly receiving in astronomy, mechanics, or in physics practical applications which their originators could never have dreamt of. Thus Apollonius erected in ancient times the stately edifice of the properties of conic sections, without having any idea that the planets moved about the sun in conic sections, and that a Kepler and a Newton were one day to come who should apply these properties to explaining and calculating the motions of the planets about the sun. The question of the practical availability of its results in other fields has at no period exercised more than a subordinate influence on mathematical inquiry. Particularly is this true of *modern* mathematical research, whether the same consist in the extended development of isolated theories or in the uniting under a higher point of view of theories heretofore regarded as different.[1]

This independence of its character has rendered the results of pure mathematics independent also of the accidental direction which the development of civilisation has taken on our planet; so that the remark is not altogether without justification, that if beings endowed with intelligence existed on other planets, the truths of mathematics would afford the only basis of an understanding with them. Uninterruptedly and wholly from its own resources mathematics has built itself up. It is scarcely credible to a person not versed in the science, that mathematicians can derive satisfaction from the comfortless and wearisome operation of heaping up demonstration on demonstration, of rivetting truth on truth, and of tormenting themselves with self-imposed problems, whose solution stands no one in stead, and affords satisfaction to no one but the solver himself. Yet this self-sufficiency of mathematicians becomes a little more intelligible when we reflect that the progress which has been made, particularly in the last few decades, and which is uninfluenced from without, does not consist solely in the accumulation of new truths

[1] Cf. Felix Klein, "Remarks Given at the Opening of the Mathematical and Astronomical Congress at Chicago." *The Monist* (Vol. IV, No. 1, October, 1893).

and in the enunciation of new problems, nor solely in deductions and solutions, but culminates rather in the discovery of new methods and points of view in which the old disconnected and isolated results appear suddenly in a new connexion or as different interpretations of a common fundamental truth, or finally, as a single organic whole.

Thus, for example, the idea of representing imaginary and complex numbers in a plane, two apparently different branches, the theory of dividing the circumference of a circle into any given number of equal parts, and the theory of the solutions of the equation $x^n = 1$, have been made to exhibit an extremely simple connexion with one another which enables us to express many a truth of algebra in a corresponding truth of geometry and *vice versa*. Another example is afforded by the discovery which we chiefly owe to Alfred Clebsch, of the relation which subsists between the higher theory of functions and the theory of algebraic curves, a relation which led to the discovery of the condition under which two curves can be co-ordinated to each other, point for point, and hence also adequately represented on each other. Of course such combinations and extensions of view possess a much greater charm for the mathematician than the mere accumulation of truths and solutions, whose fascination consists entirely in their truth or correctness.

From these three cardinal characteristics, now, which distinguish mathematical *research* from research in other fields, we may gather at once the three positive characteristics that distinguish mathematical *knowledge* from other knowledge. They may be briefly expressed as follows; first, mathematical knowledge bears more distinctly the imprint of truth on all its results than any other kind of knowledge; secondly, it is always a sure preliminary step to the attainment of other correct knowledge; thirdly, it has no need of other knowledge. Naturally, however, there are associated with these characteristics which place mathematical knowledge high above all other knowledge, other characteristics which somewhat counterbalance the great superiority which mathematics thus appears to have over the other sciences. In order to show more distinctly the nature of these characteristics, which we prefer to call

negative, we shall select and confine our remarks to a branch which is commonly taken to be synonymous with mathematics, namely, to arithmetic in the broadest sense of the word.

The subject of inquiry in arithmetic is numbers and their combinations. On this account arithmetic is, of all sciences, most free from what lies outside its boundaries. Perception by the senses is necessary only in an extremely insignificant measure for the understanding of its definitions and premises. It is possible to acquaint a person who lacks both sight and hearing with the fundamental principles of arithmetic solely by the medium of "time." Such a person needs only the sense of feeling. By slight excitations of his skin, induced at equal or unequal intervals of time, he can be led to the notion of differences of time and hence also to the notion of differences of number. Uninfluenced by matter and force, independently, too, of the properties of geometrical magnitudes, arithmetic could be conducted solely by its own intrinsic potencies to its highest goals, drawing deductively truth from truth, without a break.

But what sort of a science should we arrive at by this method of procedure? Nothing but a gigantic web of self-evident truths. For, once we admit the first notions and premises to which a man thus bereft of his senses can be led, we are compelled of necessity also to admit the derivative results of arithmetic. If the beginnings of arithmetic appear self-evident, the rest of it, too, bears this character. Owing to this deductive character of arithmetic, and to its exemption from influence from without, this science appears to one person extremely attractive, while to another it appears extremely repulsive, according as each is constituted. Be that as it may, however, a finished and complete science of this character subserves no purpose in the comprehension of the world, or in the advancement of civilisation. Hence, an arithmetic which heaps up theorem on theorem with never a thought of how its results are to be turned to practical account in the acquisition of knowledge in other fields, resembles an inquisitive physician, who, taking up his abode in a desert, should arrive there at momentous results in bacteriology, but should bear them with him to his grave, without their ever redounding to the benefit of humanity. The value of

arithmetical knowledge lies entirely in its applications. But this constitutes no reason why many mathematicians, pursuing their purely deductive bent of mind, should not devote themselves exclusively to pure arithmetical developments and leave it to others at the proper time to turn to the material profit of the world the capital which they have garnered.

Geometry, on the other hand, must have recourse in a much higher degree than arithmetic to the outside world for its first notions and premises. The axioms of geometry are nothing but facts of experience perceived by our senses. The geometry which Bolyai, Lobatchewsky, Gauss, Riemann, and Helmholtz created and which is both independent of the eleventh axiom of Euclid and perfectly free from self-contradictions, has supplied an epistemological demonstration that geometry is a science that rests on the observation of nature, and therefore in the correct sense of the word, is a natural science.

Yet what a difference there is, for instance, between geometry and chemistry. Both derive their constructive materials from sense-perception. But whilst geometry is compelled to draw only its first results from observation and is then in a position to move forward deductively to other results without being under the necessity of making fresh observations, chemistry on the other hand is still compelled to make observations and to have recourse to nature.

It follows, therefore, that a given act of geometrical knowledge and a given act of chemical knowledge are with respect to the certainty of the truth they contain not qualitatively but only quantitatively different. In chemistry the probability of error is greater than in geometry, because more numerous and more difficult observations have to be made there than in geometry, where only the very first premises, which no man with sound senses could ever impugn, rest on observation.

The preceding reflexions deprive mathematical knowledge of that degree of certainty and incontestability which is commonly attributed to it when we say a thing is "mathematically certain." This certainty is lessened still more as we pass to the semi-mathematical sciences, where mechanics has the first claim to our at-

tention. All the notions of mechanics, and consequently of all the other departments of physics, are composed, by multiplication or division, of three fundamental notions—length, time, and mass. That is to say, to the notions of geometry resting on length and its powers, two other fundamental notions, time and mass, are added, which, joined to that of length, lead to the notions of force, work, horse-power, atmospheric pressure, etc. The knowledge of mechanics, thus, highly certain though it be, is rendered less certain than that of geometry and *a fortiori* than that of arithmetic. The uncertainty of knowledge continues to increase in branches which are still more remote from mathematics, owing to the increasing complexity of the observational material which must here be put to the test.

Still, although mathematical knowledge does not lead to absolutely certain results, it yet invests known results with incomparably greater trustworthiness than does the knowledge of the other sciences. But after all, it remains a useless accumulation of capital so long as it is not turned to practical account in other sciences, such as metaphysics, physics, chemistry, biology, political economy, etc. Hence also arises an obligation on the part of the other sciences, so to shape their problems and investigations that they can be made susceptible of mathematical treatment. Then will mathematics gladly perform her duty. The moment a science has advanced far enough to permit of the mathematical formulation of its problems, mathematics will not be slow to treat and to solve these problems. Mathematical knowledge, aristocratic as it may appear by the greater certainty of its results, will, so far as the advancement of human kind is concerned, never be more than a useless mass of self-evident truths, unless it constantly places itself in the service of the other sciences.

H. SCHUBERT.

HAMBURG.

BOOK REVIEWS.

Post-Darwinian Questions, Heredity and Utility. Part II. of *Darwin, and After Darwin*. By the late *George John Romanes, M. A., LL. D., F. R. S.* Chicago: The Open Court Publishing Company. 1895. Pages, 344. Price, $1.50.

The second part of the admirable work, *Darwin, and After Darwin*, has been long anticipated with its promise of a clear expression of Mr. Romanes's views upon the most vital problems of contemporary evolution.

The preparation of Part II. was frequently interrupted by the author's illness and was suddenly terminated by his untimely death. It now finally appears with the able editorial supervision of Prof. C. Lloyd Morgan. Although written under many difficulties, Mr. Romanes's best qualities shine forth in this volume,—his absolute independence of opinion, his clear, critical faculty, his earnest desire to arrive only at the truth. None of his English contemporaries have shown the two former qualities in so marked a degree, excepting perhaps his own editor. At the outset the introductory chapter upon the Darwinism of Darwin and of the Post-Darwinian schools sets forth in a more lucid manner than has been seen before the differences of the newer "Schools." These differences shade into each other as gradually as the colors of the spectrum when we pass from the Anti-Selectionists (Sachs, Pfeffer, and Henslow), Neo-Lamarckians (Spencer, Cope, Eimer), Darwinians (Romanes, Galton), Neo-Darwinians (Wallace, Poulton), to the Weismannians. Considering the tenets of these Schools in the above order, we observe that the factors of self-adaptation, definite variation and evolution guided by inheritance, fall from their maximum to their minimum while the factors of evolution guided by fortuitous variation and natural selection rise from their minimum to their maximum. Thus the two extremes of *law* and of *fortuity* respectively as the basal phenomena of evolution are diametrically opposed.

We feel that a fine, clear mind has shaped this and the succeeding chapters, but not a master mind. We feel the lack of a high order of originality and the failure to grasp the significance of all the evidence now available from physiology, botany, zoölogy, and palæontology. Apparently, no man of our time has the genius to marshal in their proper order the countless discordant facts from these four

quarters of biological research and fully state the problem which is now far broader than that which faced Darwin. We are glad to add as a tribute to our late lamented author that his vision has been clearer and broader than that of ninety-nine out of every hundred of his contemporaries, and that we shall sorely miss him from among our counsellors.

Following this introductory historical and critical chapter the author proceeds to the two main subjects of his work; not to the whole subject of Heredity, but to the special problem of Inheritance of Acquired Characters, and secondly to the Wallace-Weismann doctrine of Utility, leaving Isolation and Physiological Selection for a third Part. As regards inheritance, he nowhere defines his views more positively than in the following paragraph:

"For my own part, as stated in the *Examination*,[1] I have always been disposed "to accept Mr. Galton's theory of Stirp in preference to that of Germ-Plasm on "this very ground—i. e., that it does not dogmatically exclude the possibility of an "occasional inheritance of acquired characters in faint though cumulative de-"grees."

In other words, he accepts the "*continuity*" without the absolute "isolation" of the hereditary substance, and goes on to say that the only question in debate is whether, as Darwin believed, causes of the Lamarckian order modifying "continuity" are not absolutely necessary in order to explain some of the phenomena of evolution. The evidence available on either side is presumptive, not demonstrative. The logical position of one side is as strong as that of the opposite side and high authorities are very evenly divided. Among various kinds of evidence, Mr. Romanes thinks lightly of that advanced by the American palæontologists, classing it as indirect, and in the reviewer's opinion failing to recognise that palæontological evidence is entirely unique in that it gives the whole history of many adaptive characters. On the other hand he holds that in the neuro-muscular machinery, in the domain of reflex actions and instinctive actions, we may expect to find our best indirect evidence of use-inheritance as an evolution factor, for here the principles of co-ordination and co-adaptation reach their highest point. It is satisfactory to learn definitely that Mr. Romanes took his final stand with Darwin and Spencer in regarding instinct as inherited habit, but we are disappointed to find that his opinions rest wholly upon logical considerations.

After thus far committing himself to the Lamarckian theory, he immediately proceeds to take the inconsistent position that the whole line of evidence for the inherited effects of use and disuse in anatomical characters is practically worthless. The apparent influences of disuse may, he thinks, be wholly explained by his principles of "Cessation" and "Reversal of Selection" (Weismann's Panmixia), and we cannot help feeling here that he shows some favoritism for his own mental offspring. In criticism of this theory of degeneration, we cannot direct attention too

[1] *Examination of Weismannism*, The Open Court Publishing Company, Chicago.

strongly to the one illogical vein which runs through the book, namely, the assumption that certain body-cell activities are inherited while others are not, for of one fact we may feel absolutely confident, either that the Lamarckian principle is operative alike through all the live tissues containing chromatin or it is not operative at all. We cannot agree with the author that the effects of habit in the cells of the nervous system are transmitted while those in bone and muscle cells are not.

Strong as is the argument from nascent and full-fledged reflexes, we are now satiated with logic and crave experiments of the kind Lloyd Morgan is now making. It is unfair, however, to leave the impression that Mr. Romanes was of the pure logic school. He here informs us of several very ingenious lines of experimental work which he carried on for years uniformly without success (*vide* pp. 143–149), and the most original section of the present work is the full account of his repetition of the celebrated experiments of Brown-Séquard. His object was to verify these experiments and especially to meet the well-known criticism of Weismann, that the alleged transmission of induced epilepsy is due to germinal infection. His most successful operation was in the production of haematoma and dry gangrene of the ears by an injury to the restiform bodies of the brain. As regards the parents operated upon, the ear degeneration is very complete and supervenes after several weeks or months. In the progeny the morbid state occasionally reappears. It always affects members of the *same litter* at the same time and extends as a rule only to the middle third of the ear. Weismann's infection hypothesis is disproved by the failure of inoculation to produce similar results. Altogether, Mr. Romanes's experiments fully corroborate those of Brown-Séquard in principle, if not in all details, and together with those of Westphal and Obersteiner seem to establish conclusively that a profound localised injury to the nervous system is occasionally followed by the transmission of similar localised results.

It does not appear that either of these investigators undertook a microscopic examination of the restiform bodies in the progeny in order to ascertain whether the effects of mutilation were transmitted.

The author then cites the striking modifications of higher plants by change of environment under the experiments of Hoffmann, Carrière, Lesage, Bailey, Henslow, and others. It is to these modifications that the term "self-adaptation" has been applied. They undoubtedly furnish the most complete disproof of the adequacy of the "selection" theory, but Mr. Romanes certainly errs in placing them in the column of evidence of transmission of acquired characters, for the very suddenness of these environmental changes proves that we are witnessing an individual *saltation*, rather than a slowly inherited modification. A seashore plant transported to dry soil jumps into a new type as a matter of purely *individual growth*. The new type is accumulative in successive generations, and thus undoubtedly in nature, as Buffon observed a century ago, "many species are no longer what they formerly were." But just when we are forming the apparently safe induction that these somatogenic characters have become blastogenic we transport the highly modified

descendant to its old seashore home, and, *presto*, the original type reappears. The causes and extent of these remarkable "adjustments of internal relations to external relations," to use Spencer's phrase, remain to be more thoroughly investigated. They furnish the main motive of the anti-selectionists as well as the basis of the new teleology of such writers as Driesch, who believes that the purposive direction of the activities of protoplasm constitutes a problem as insoluble as the nature of life itself. Driesch does not find in these phenomena a proof of the specific Lamarckian problem, nor can we. In fact, it is essentially a distinct problem, which has arisen since Lamarck's and even since Darwin's time, although suggested by some of Darwin's critics, such as Asa Gray.

The latter half of the work, devoted to the utility problem, opens with the demonstration that Darwinism is primarily a theory of the origin of adaptations; secondarily, of the origin of species and of all natural divisions of animals and plants. This is followed by a detailed review of the whole subject of the usefulness or neutrality of characters of different kinds in the struggle for existence. As in the earlier sections, Mr. Romanes shows conclusively that he has Darwin upon his side and that the Wallace-Weismann position is ultra-Darwinian.

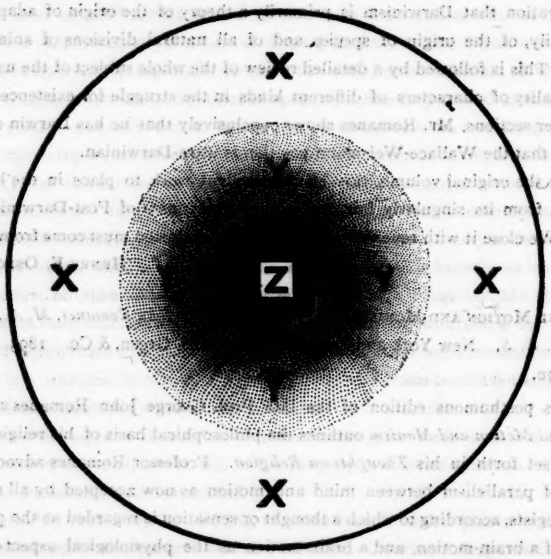
Like the original volume, this is an excellent work to place in the hands of students, from its singularly fair and accurate treatment of Post-Darwinian questions. We close it with renewed regret that the conclusion must come from another hand.

HENRY F. OSBORN.

MIND AND MOTION AND MONISM. By the late *George John Romanes, M. A., LL.D., F. R. S.* New York and London: Longmans, Green, & Co. 1895. Pages, 170.

This posthumous edition of the late Prof. George John Romanes's articles *Mind and Motion and Monism* outlines the philosophical basis of his religious position as set forth in his *Thoughts on Religion*. Professor Romanes advocates the theory of parallelism between mind and motion as now accepted by all scientific psychologists, according to which a thought or sensation is regarded as the psychical aspect of a brain-motion, and a brain-motion as the physiological aspect of a psychical event of some kind. We observe the motions of our fellow beings and conclude that their actions are accompanied with feeling the same as are our own actions of like kind. We observe objects only and objective motion, but we suppose them to be animated according to their organisation. This theory is called Monism, combining the two one-sided positions of spiritualism and materialism. Clifford calls the soul with which we endow the motions of our fellow creatures, an eject (in contradistinction to "object"), and concluding that even physical events possess an aspect that is analogous to the psychical aspect of brain-motion, speaks of the world as an eject. Romanes endorses Clifford's theory but makes his own application. Considering the fact that all motions have their psychical aspects, he concludes that we cannot know what psychical value the cosmic motions of planets

and stars may have, and drawing the adjoined diagram he establishes upon the basis of this "monistic agnosticism" his belief in the existence of God, not indeed as a verifiable theory but as an hypothesis for which there is a great probability, and which may at least provisionally be used until we find ourselves obliged to replace it by more exact knowledge. In the adjoined diagram, *Z* the dark centre of our experience represents the brain-motions of man, darkly shaded in order to indicate their deep psychic significance. *Y* represents the sphere of the lower animals whose psychic life is dimmer and less concentrated. In *X* we reach the inorganic domain, which, according to Clifford, remains unshaded on account of the absence of organisation, while to theologians and theists generally it ought to be shaded more deeply than *Y* and *Z*.



The existence of the God of Professor Romanes is, as conceded by himself, quite provisional and hypothetical, and is therefore unavailable as a religious idea. But granting that Professor Romanes's God existed and was endowed with a personal consciousness, what would God be? He would be a huge, world-large ego, a gigantic personality, an individual creature of an enormous size; but he would be a concrete and particular being of a definite organisation like ourselves. He would be the spirit of the universe, and would, like all souls, be thinking, willing, and plodding. This is Brahma, the world-soul, but not God, for such a world-ego lacks all the attributes of divinity and possesses all the qualities of individual creatures. What Buddha says of Ishvara, the personal God, applies in every respect with equal force to Professor Romanes's God; granting that he exists, we can recog-

nise in him only our eldest brother, not the ultimate authority of moral conduct. For he is not identical with the eternal Divinity which appears in the enlightenment of all the Buddhas, and Buddha's claim of being superior to Ishvara and Brahma is justified. Compare this world-soul-God to the Nomotheism, as we may call the God-conception of the Religion of Science, and you will at once understand that the true God cannot be an individual, not a particular being, not a concrete personality, but must be the eternal and omnipresent, supernatural[1] and superpersonal,[2] the immutable and irrefragable order of existence, the Logos that was in the beginning and whose divinity appears in the cosmic order which naturalists reveal to us in their various aspects called laws of nature.

Professor Romanes's God, in order to create and govern the world correctly, must first make himself acquainted with the eternal laws of being, he must make his calculations and consider his plans with reference to the laws of mechanics; he must work out designs which are liable to miscarry unless they agree with the immutable norms of eternal necessity. But Professor Romanes might say with others who share his belief in a personal world-ego-God, that God created the eternal laws of the universe; to which I reply that the formal laws (such as $2 \times 2 = 4$, the conservation of matter and energy, causality, etc.) are intrinsically necessary, and God could not have created them differently from what they are. If they are not parts and parcels of God, they are certainly more eternal, more divine, more immutable than God. They would be, and they are, the God of any world-soul-God; and if they are the god of all gods, why should not we recognise in them the sole God, the source of wisdom and righteousness. Taking this view, we understand that every rational being that is in possession of univeral concepts, bears God's image, and the morally perfect man is "God become flesh."

This is in brief our view of God as contrasted with Professor Romanes's God.

P. C.

SYSTEMATISCHE PHYLOGENIE DER WIRBELTHIERE. (Vertebrata.) By *Ernst Haeckel*. Berlin: Georg Reimer. 1895. Pages, 680.

The first part of Professor Haeckel's "Systematic Phylogeny" appeared in 1894, and we may expect the second, which treats of the Invertebrates, in 1896. The present, or third part, gives in outline a hypothetical ancestral history of the Vertebrates. The original sketch and idea of this life-history of terrestrial organisms was propounded in 1866, and put in a popular form in 1868. The enormous

[1] The term "supernatural" must be taken in the literal sense of the word. The intrinsic necessity and universality which Kant discovered in transcendental cognition, implies that the most universal laws (such as $1 + 1 = 2$) hold good not only for this actual world in which we live but for any possible world; they are applicable to nature and to anything whether existent or non-existent. The Logos is not limited to our world-system; it is universally supreme; in a word, the Logos is supernatural.

[2] It would be misleading to conceive of God, the irrefragable law of existence, as simply bare of personality. God is the prototype of all personality, and possessing the conditions of personality, we propose to call him "superpersonal."

advances made in all the departments underlying our phylogenetic insight into life have now, after thirty years, rendered it possible for the author to fill out the gaps and supply many of the details of the original system. None but a specialist could judge or appreciate the absolute scientific legitimacy of such a tremendous plan. But be that what it may, nothing but unqualified admiration is due to the indefatigable efforts and comprehensive erudition of the great naturalist, its author, who has done more perhaps than any scientist living towards stimulating, organising, and interpreting biological inquiry, and who, with a modest confession of the faults of his proposed system, merely hopes that his new sketch will contribute, in some degree, to the promotion and extension of that genuine natural history, which, in his opinion, is destined to solve the highest problems of science. We find in the last remark, indeed, the keynote of the work. It is not a text-book, but merely a hypothetical structure, designed to show the lines along which further work in the construction of the hypothetical genealogy of life is to be conducted. The value of a plausible but intricate hypothesis can be determined only after its main conclusions have been elaborated; but the discipline of such a plan and its execution, in a heuristic regard, is invaluable. T. J. McC.

ALGEBRA UND LOGIK DER RELATIVE. Der Vorlesungen über die Algebra der Logik dritter Band. By *Ernst Schröder*. Leipsic: B. G. Teubner. 1895. Pages, 649.

The materials of Prof. Ernst Schröder's great work on the *Algebra and Logic of the Relatives* appear to grow under his hands. The third volume was intended as the last part, and here we have the first stately instalment only of the third volume, but this is exactly what we must expect, considering the fact that we have here the foundation of a new science, the algebra of thought, that is to say, language expressed in the abstractest possible symbols, which, it is hoped, will enhance man's power of thought as much as algebra made the solution of our various arithmetical problems easier. As to the plan of the whole work, we refer the reader to our review of the first volume of the book. The present volume treats mainly on the operation of binary and uninary relatives. Professor Schröder draws largely upon Charles Peirce's methods, as set forth in scattered articles, and on Dedekind's theory of concatenations.

We must here be satisfied with the mere announcement of the book, as we intend to give it a more careful review on its completion. P. C.

ANARCHY OR GOVERNMENT? An Inquiry in Fundamental Politics. By *William Mackintire Salter*. New York and Boston: Thomas Y. Crowell & Co. 1895. Pages, 176. Price, 75 cents.

"In a time of social unrest and uncertainty like the present," says Mr. Salter, "it may not be amiss to go back to first principles." It is the author's object to get at the norms which underlie the action of government, so that we can readily judge

of the rightness or unrightness of particular acts of the State. The book is a summary of lectures which he gave in 1894 at the School of Applied Ethics in Plymouth and afterwards in Philadelphia. His central conviction is, "that political advances "are frequently opposed on grounds which, if acted on and carried to their appro- "priate conclusion, would result in undoing government altogether—save for pur- "poses of defence in time of war." He says further:

"The justification of government is always not its abstract desirability, but its "practical necessity. I think that the events in Pullman and in Chicago, indeed the "trend of affairs in the modern industrial world generally, go to show that our old "system of liberty or anarchy [by anarchy Mr. Salter understands a state of things "without government] is breaking down, just as feudal anarchy broke down at the "beginning of the modern epoch in Europe in the fifteenth and sixteenth centuries."

We see the author is in favor of a species of qualified nationalism.

Mr. Salter writes a pleasant, earnest, and simple style, and has the merit, now-a-days rare among authors, of never inflicting large books upon the public. He develops his conclusions in connexion with practical examples, and we may recommend his book to the general reader as helpful and stimulating. μκρκ.

THE RELIGIONS OF INDIA. By *Edward Washburn Hopkins, Ph. D.* (Leipsic), Professor of Sanskrit and Comparative Philology in Byrn Mawr College. Boston, U. S. A., and London: Ginn & Company. 1895. Pages, 612. Price, $1.85.

Dr. Morris Jastrow, Professor of Semitic Languages in the University of Pennsylvania, has projected the publication of a series of handbooks on the history of religions, of which he is to be the editor. It is his object to produce a series of manuals for the historical study of religions in our universities and seminaries, while at the same time to meet the requirements of reliable reference books, summing up the present status of our knowledge of the religions of antiquity, and giving all in the popular manner of presentation which is demanded by the growing interest taken by people of all classes in the historical and practical study of this subject, which was notably promoted by the recent World's Parliament at Chicago. The series will contain a treatise on "The Religion of Babylonia and Assyria" by the editor himself, and this will be followed by other manuals by equally eminent authorities on "The Religion of the Ancient Teutons," "The Religion of Persia," "The Religion of Israel," and by a general "Introduction to the History of Religions" by Prof. C. H. Toy of Harvard.

The present volume is the first number of the series. Its selection as a leading volume, the position of the author, and his evident full acquaintance with the best literature on the subject and with the original sources, are a sufficient guarantee of the trustworthiness and merits of the book. The author's idea has been to conduct the reader to a knowledge of the religions of India by actual illustrations and facts as distinguished from abstract comment upon, and exegesis of, the subject-matter

of those religions. His method is thus the opposite of that of Barth in his admirable and unapproached handbook on this subject. He says: "Whereas Barth . . . aimed at making his reader know all about the religions of India, we have sought to make our reader know those religions. We have tried to show the lines on which developed the various theological and moral conceptions of the Hindus, not only by furnishing, from the point of view of a foreign critic, an annotated narrative of the growth of these conceptions, but also and chiefly by taking the reader step by step through the literature that contains the records of India's dogmas." He has sought to cause the religions of India "to reveal themselves." He has not, he says, much to offer to the professional Indologian, as his work is intended only for students, but he thinks that his review of the relation of Vedic belief to that of the primitive Aryans is one that might be substituted with advantage for many current theories. This view would seem to be that *deva* worship is the immediate predecessor of the Hindu religion—a belief which is substantiated by Zarathustra's rejection of the *daevas*, which must be the same as devas.

But the author's special field of investigation has lain along the lines of Hinduism, and in his chapters on this subject he expects that Sanskrit scholars of the Hindu epoch will find something worthy of their attention. The subjects treated are, the character of the people and country, the Rig Veda in all its aspects, the early Hindu divinities and those of other Aryans, Brahmanism, Jainism, Buddhism, Hinduism, the Purānas, modern Hindu sects, religious traits of the wild tribes, and the relations of India and the West. The book contains a passable map of India, which is probably sufficient for its purposes, a tolerable index, but by no means exhaustive for a text-book or reference-book, and lastly, the matter is very well suited as regards sub-titles and general typography for the ends of instruction. The author has wisely rejected the cumbrous mode of transcription of the *Sacred Books of the East*, and employed a simpler yet certainly sufficient method. μερκ.

THE SAMKHYA-PRAVACANA-BHASYA, OR COMMENTARY ON THE EXPOSITION OF THE SAMKHYA PHILOSOPHY. By *Vijñanabhiksu*. Edited by *Richard Garbe*. Boston: Ginn & Co. 1895. Pages, 195.

Prof. Richard Garbe, who is well known to the readers of *The Monist* by his contributions on Indian and Greek philosophy, has recently been the recipient of a high honor, being made the successor of Roth, the famous Professor of Sanskrit in Tübingen. His co-operation in the Harvard Oriental Series, of which Prof. C. R. Lanman is editor, is one of the gratifying and unmistakable evidences of the international character which research is now assuming and especially of the high and important place which American scholarship and enterprise is taking in the world of inquiry. Professor Garbe says: "I hope and trust that the present edition will "prove to be one of the nearest approaches to absolute correctness to be found "among Sanskrit texts. If this turns out to be the case, the result is to be ascribed "chiefly to the unselfish assistance which Professor Lanman has rendered me in

"the proof-reading, and for which my most hearty thanks are due to him." The present book is the text of a commentary on the sûtras or aphorisms of the Sânkhya philosophy, for a knowledge of which we may refer non-Sanskrit students to Professor Garbe's article in *The Monist* for January, 1894, to his article "Sânkhya" in *Johnson's Universal Cyclopædia*, or to his exhaustive exposition of the subject in his recent work, *Die Samkhya-Philosophie*, Leipsic, 1894. μ.

DIE WEISSAGUNGEN JESU CHRISTI VON SEINEM TODE, SEINER AUFERSTEHUNG UND WIEDERKUNFT UND IHRE ERFÜLLUNG. By *Prof. Paul Schwartzkopff*, Ph.D. Göttingen: Vandenhoeck und Ruprecht. 1895. Pages, 205.

The present booklet is about one-fourth of a larger work, the subject of which is "God's revelation in Jesus Christ according to its content, extent, and limits." The author has published this, his inquiry into "the prophecies of Jesus Christ, concerning his death, resurrection, and his second coming, and their fulfilment," in advance of his larger book, on account of their paramount importance. His endeavor has been critically to discern, and psychologically to understand, the full moral and religious import of the highest revelation, by discriminating between the divine substance and the human form, which latter is historically conditioned. His aim is to prove the centrality of Jesus in the Christian revelation, which he does by showing that whatever can be found to be incidental or transient belongs to that which is historically conditioned, must be referred to the form, not the substance, of the mission of Jesus.

The main crux of our New Testament exegesis is the problem of the bodily resurrection of Christ, and we possess in this book a review of its main difficulties. Professor Schwartzkopff has, after long hesitation, come to the conclusion that the bodily resurrection of Jesus has to be discarded in order to be replaced by the belief in a spiritual personality of Jesus. He says (page 78): "Undoubtedly the "belief of the first Christians in the resurrection of Jesus from the grave is the "foundation of the Church. But it is true, too, that the victorious power of their "belief did not consist in the form of their revelation, but in its substance. The "appearances of Christ were evidences of the external form of the certainty of their "belief in the Messianity of the victorious Jesus. From these appearances, which "were conceived to be bodily, the early Christians drew the conclusion of a resur-"rection from the grave. The empty grave was a corroboration. This conception "had no value in itself as regards the essence of their faith, but is merely of his-"torical interest. It was of importance only that the early Christians should gain "faith in the eternal mediatorship of the Son of God. This was the import of the "Messianity of Jesus, and this was regarded by Paul also as the kernel of Chris-"tianity."

Professor Schwartzkopff passes in review the various interpretations given by the various theological schools of the resurrection. He states the fact of the prophecy of Jesus, and explains the origin of the belief of his resurrection on the

third day, and devotes to the belief in the corporeality of the Christ-appearances not less than forty-three pages.

Another problem of great importance which is discussed in the latter part of the book, is the belief of Jesus in the establishment of a Kingdom of God upon earth. The fact that Jesus believed in his second coming, which was to take place so soon that some persons of his own generation would still witness it, cannot be doubted, for the very non-fulfilment of these prophecies is the best proof that they are genuine. Later Christian writers would not have ventured to state them in the form in which they stand in the Gospels. Here the historian must psychologically analyse and comprehend the nature, the growth, and the importance of Christ's ideal, and Professor Schwartzkopff has done the last well. But he is confronted with the difficult problem that Jesus, who to him is the Son of God and the medium of God's revelation to mankind, is subject to an erroneous conception, so far as the mode of his future life and mission are concerned. And he says that Jesus appears indifferent toward all those common beliefs of his time which do not touch the very essence of his mission. His attitude is purely receptive, so as to be a mere echo of the views of his contemporaries. And certainly Christians will naturally have to accept this interpretation, because otherwise Jesus would have to be held responsible for all the superstitions and errors of his time, such as the belief in possession and the demoniacal character of diseases, etc.

As to the main conclusion of the author, which consists in his belief in the spiritual personality of Jesus, we have to say that in the form in which he holds it, he makes it a matter of personal conviction. He does not enter into the problem of what the nature of a spiritual personality may be, but we feel confident that as soon as that is investigated we shall not only be able to explain the significance of the belief in Christ's resurrection, but also to prove that Christ always was, is still, and will ever remain a living presence in the Christian Church; and that his aspirations and his religious ideal, which *de facto* constitute Christ's spiritual personality, have reacted, as a leaven in the dough, so powerfully upon mankind, that its evolution has been conducted into new channels and that historians are justly entitled to date a new era from the birth of Christ.

Though Professor Schwartzkopff's conception of Christ's spiritual personality may be different from ours, we must confess that his book is very sympathetic, for it proves that his religious faith is both honest and strong—honest to investigate the problem and face its difficulties; strong to hold fast that which after a careful scrutiny and purification appears to him to be the substance of the Christian message of salvation. P. C.

ESSAYS AND NOTICES, PHILOSOPHICAL AND PSYCHOLOGICAL. By *Thomas Whittaker, B. A.* London: T. Fisher Unwin. 1895. Pages, 370. Price, 16s.

Mr. Whittaker is well known to the readers of philosophical magazines as the writer of competent and accurate analyses of philosophical works, in which he has not

omitted to weave suggestive speculations. He has collected in the present volume nearly all the essays of this character which he has written for the magazines since 1881. They cover a wide field of philosophical and psychological thought, as will be apparent from their titles which we here subjoin: "A Critical Essay in the Philosophy of History"; "'Mind-Stuff' from the Historical Point of View"; "Giordano Bruno"; "The Musical and the Picturesque Elements in Poetry" "Individualism and State-Action"; "Volkmann's Psychology"; "Politics and Industry"; "On the Nature of Thought"; "The Theory of Justice"; "Animal Intelligence"; "Æsthetics"; "On the Ethics of Naturalism"; "The Philosophy of Redemption"; "Philosophical Antinomies"; "Giordano Bruno and his Time"; "Dead Matter and Living Matter"; "On Free-Will"; "Idealism in England in the Eighteenth Century"; "Physical Realism"; "Reality as Phenomenon"; "Thought and Life"; "The Laws of Imitation"; "The Problem of Causality"; "The Philosophical Basis of Evolution"; Appendix: "Correspondence with M. Renouvier"; "The Psychology of Stimulants." The common motive of all these essays and reviews has been "an effort to arrive at something positive through criticism," and thus is justified their appearance in a single volume. Mr. Whittaker does not assert that he has "attained any result capable of being summed up in a complete formula," but he believes, nevertheless, that in questions of metaphysics something can be said with certainty, and something with a high degree of intellectual assurance. And that is briefly as follows: he finds that absolute certainty is not to be sought in ontology but only in the theory of knowledge. "All that is demonstrable in metaphysics is idealism in the strict philosophical sense." He takes the upshot of science to be merely nominalistic, and asserts that it requires as its complement a theory of reality, that is a metaphysic, on behalf of which he puts in a plea against agnosticism as fettering the rightful impulse of mankind to speculate. But as to what this certainty is, Mr. Whittaker only arrives at extremely abstract and formal propositions, although he admits as theoretically consistent either a doctrine of monads or a doctrine of a permanent universal being, *intellectus infinitus*, for the further development of reality. The style of these essays is agreeable and they show much erudition. In the way of comments upon the history of philosophy and current problems they will be valuable. μκρκ.

THE INDIVIDUAL AND THE STATE. An Essay on Justice. A Thesis Accepted by the Faculty of Cornell University for the Degree of Doctor of Philosophy. By *Thomas Wardlaw Taylor, Jr., M. A.* Boston: Ginn & Co. 1895. Pages, 90.

It is fast becoming the custom in our universities, it would seem, to *print* theses accepted for the doctorate, and when presented by mature students and of intrinsic value, the custom is certainly a good one. The latest document of this character which has come into our hands, is the present one by Mr. Taylor. It seems to fulfil the above criteria and is written in an earnest philosophical spirit, not too heavy,

and showing withal familiarity with the best literature and sources of the subject. We may give an idea of his views by the following quotation, where he is speaking of individualism and socialism: "The individual serves the social organism of "which he is a member, but at the same time he is more than a member of that "organism, and the organism serves him, and it is impossible to say that the indi-"vidual is above society, or that society is above the individual, for in certain "aspects each proposition is true." μ.

DIE MODERNE PHYSIOLOGISCHE PSYCHOLOGIE IN DEUTSCHLAND. Eine historisch-kritische Untersuchung mit besonderer Berücksichtigung des Problems der Aufmerksamkeit. By *Dr. W. Heinrich*. Zürich: E. Speidel. 1895. Pages, 235. Price, M. 4.

After an historical introduction, treating of the influence of Christianity on science, and leading up to the beginning of Herbart's "psychology without a soul," Dr. Heinrich discusses the theories of Fechner, the father of experimental investigation, and Helmholtz, G. E. Müller and Pilzecker, Wundt, N. Lange, Külpe, Münsterberg, Ziehen, and Avenarius. The standard by which our author proposes to measure the theories of these men is "the law of psychical parallelism"; but in doing so he misrepresents Wundt's position, and condemns it as metaphysical. It is true enough that many disciples of Wundt have gone to the extreme of changing psychology to a mere measurement of reaction-times and other trivialities, but Wundt himself represents more than that. The reviewer is not an adherent of Wundt's, he does not even accept several of his basic propositions, but he believes that some of Wundt's disciples show little gratitude toward their master when forgetful of what they learned from him and what modern psychology owes him, they attack him on small issues, which, closely considered, are mere misconceptions of Wundt's real position. Whatever Wundt's shortcomings may be, his influence upon the evolution of psychology should not be underrated. If the author did not learn more from Wundt than the digest on pp. 80–126, with the overcritical summary on page 116, it is certainly not Wundt's fault. The appreciation which our author grudges to Wundt, is given in large measure to Münsterberg, whose merits are strangely exaggerated. In fact, the latter and Richard Avenarius are apparently, in the whole history of German psychology, the only ones with whom Dr. Heinrich finds no fault.

The problem of attention, the treatment of which is promised in the title of the book, is only incidentally touched upon, as, for instance, when the author presents us with a brief extract from Ribot's *Psychology of Attention* (on pp. 168–170).

T. Βρλν.

PERIODICALS.

INTERNATIONAL JOURNAL OF ETHICS. Vol. VI. No. 2.

THE HEGEMONY OF SCIENCE AND PHILOSOPHY. By *Alfred Fouillée*.—SOCIAL EVOLUTION. By *David G. Ritchie*.—THE ETHICAL LIFE AND CONCEPTIONS OF THE JAPANESE. By *Tokiwo Yokoi*.—THE SOCIAL QUESTION IN THE CATHOLIC CONGRESSES. By *John Graham Brooks*.—NATIONAL PREJUDICES. By *John Code Bayly*.—DISCUSSIONS.—BOOK REVIEWS.—(Philadelphia: International Journal of Ethics, 1305 Arch Street.)

THE PSYCHOLOGICAL REVIEW. VOL. II. No. 6.

THE CONFUSION OF CONTENT AND FUNCTION IN MENTAL ANALYSIS. By *Dickinson S. Miller*.—THE ORIGIN OF A "THING" AND ITS NATURE. By *J. Mark Baldwin*.—SOME OBSERVATIONS ON THE ANOMALIES OF SELF-CONSCIOUSNESS (II.) By *Josiah Royce*.—THE PERCEPTION OF TWO POINTS NOT THE SPACE-THRESHOLD. By *Guy Tawny*.—DISCUSSION, ETC.—New York and London: Macmillan & Co., 66 Fifth avenue.)

THE AMERICAN JOURNAL OF PSYCHOLOGY. Vol. VII. No. 1.

EXPERIMENTS ON FECHNER'S PARADOXON. By *T. R. Robinson, B. A.*—THE INFLUENCE OF THE COLOR OF SURFACES ON OUR ESTIMATION OF THEIR MAGNITUDE. By *J. O. Quantz, B. A.*—MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF CORNELL UNIVERSITY.—SOME QUESTIONS OF THE CUTANEOUS SENSIBILITY. By *W. B. Pillsbury, B. A.*—ON THE EFFECTIVE TONE OF SIMPLE SENSE-IMPRESSIONS. By *B. R. Major, B. S.*—A PSYCHOLOGICAL VOCABULARY. By *E. B. Titchener*.—MINOR STUDIES FROM THE PSYCHOLOGICAL LABORATORY OF WELLESLEY COLLEGE.—"THE CONTINUED STORY." By *Mabel W. Learoyd* and *Maude L. Taylor*.—SYNÆSTHESIA. By *Mary Whiton Calkins*.—PSYCHOLOGICAL LITERATURE.—(Worcester, Mass.: J. H. Orpha.)

MIND. NEW SERIES, No. 16.

NOTES ON THE THEORY OF VALUE. By *J. S. Mackenzie*.—ATTENTION AND WILL: A STUDY IN INVOLUNTARY ACTION. By *A. F. Shand*.—ORGANIC EVOLUTION AND MENTAL ELABORATION. By *H. M. Foston*.—KNOWLEDGE. By *W. Smith*.—DISCUSSIONS, ETC.—(London and Edinburgh: Williams & Norgate.)

REVUE PHILOSOPHIQUE. Vol. XX. Nos. 10 and 11.

Le "Parlement des religions." By *L. Arréat.*—La physiologie dans les métaphores. By *Ch. Féré.*—August Comte: Etude critique et psychologique (Concluded). By *Dugas.*

Le Développement des idées abstraites chez l'enfant. By *B. Perez.*—Activité cérébrale et conscience. By *A. Forel.*—La Sociologie ethnographique et l'Histoire: leur opposition et leur conciliation. By *G. Richard.*—La Théorie de l'induction d'après Sigwart (I). By *H. Lachelier.*—Analyses et comptes rendus, etc.—(Paris: Felix Alcan.)

THE PHILOSOPHICAL REVIEW. Vol. IV. Nos. 5 and 6.

Self-Consciousness, Social Consciousness, and Nature. I. By *Prof. J. Royce.*—The Absolute and the Time-Process. By *Prof. John Watson.*—The "Feelings." By *Dr. Herbert Nichols.*—Discussions: Desiderata in Psychology. By *Prof. J. H. Hyslop*; "Basal Concepts." By *Prof. A. T. Ormond.*—Book Reviews, etc.

Self-Consciousness, Social Consciousness, and Nature. II. By *Prof. J. Royce.*—The Question of Authority in Early English Ethics. By *Dr. Norman Wilde.*—Ethics, Theoretical and Applied. By *Ernest M. Bowden.*—Natura Naturans. By *William W. Carlile.*—Discussions: Professor Watson on Fullerton's Translation of Spinoza. By *Prof. D. S. Miller*; An Explanation. By *Prof. J. H. Hyslop.*—Book Reviews, Etc.—(Boston, New York, Chicago: Ginn & Co.)

ZEITSCHRIFT FÜR PSYCHOLOGIE UND PHYSIOLOGIE DER SINNESORGANE. Vol. IX. Nos. 3 and 4.

Ueber erklärende und beschreibende Psychologie. By *Herm. Ebbinghaus.*—Skizze einer Willenstheorie. By *G. Simmel.*—Quantitative Untersuchungen über das "optische Paradoxon." By *G. Heymans.*—Litteraturbericht.—(Hamburg and Leipsic: Leopold Voss.)

VIERTELJAHRSSCHRIFT FÜR WISSENSCHAFTLICHE PHILOSOPHIE. Vol. XIX. No 3.

Ueber die Hertz'sche Mechanik. By *G. Helm.*—Ueber subjectlose Sätze und das Verhältniss der Grammatik zur Logik und Psychologie. (VII. Concluded.) By *A. Marty.*—(Leipsic: O. R. Reisland.)

ARCHIV FÜR SYSTEMATISCHE PHILOSOPHIE. Vol. I. No. 4.

Kritische Beleuchtung einiger Punkte in E. Schröder's Vorlesungen über die Algebra der Logik. By *G. Frege.*—Wie gelangen wir zur Freiheit und Harmonie des Denkens? By *A. Spir.*—Jahresbericht über die Erscheinungen der Ethik aus dem Jahre 1894. By *F. Jodl.*—Rassegna dei lavori di Filosofia sistematica pubblicata in Italia dal gennajo 1893 al luglio 1894 presentata da *R. Ardigo.*—Bibliographie der philosophischen Litteratur des Jahres 1894, etc., etc.—(Berlin: Georg Reimer.)